The Origin of AmaNdebele mathematical artefacts in KwaMsiza Mabhoko community, North-West Province.

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Thesis submitted in fulfilment of the requirements for the degree *Doctor of Philosophy in Social Science with Indigenous Knowledge Systems* at the North-West University

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ABSTRACT

African history shows that all cultures are mathematised, in that people within any culture use ideas of mathematics in their everyday life. In recent years, the use of historical and ethnomathematical research methods has aided a better understanding of the history of mathematics in Africa. Considering this, the origin of AmaNdebele mathematical artefacts in KwaMsiza, Mabhoko community, North-West province, was studied in this study. The following are the four data chapters that were used in this study: The first was to investigate the historical origin of the AmaNdebele mathematical artefacts. The second was to investigate the cosmic genesis of the AmaNdebele mathematical artefacts. The third was to explore the cultural identity from the AmaNdebele mathematical artefacts. The fourth was to explore how the AmaNdebele mathematical artefacts have been protected and preserved.

This study was guided by the eZiko Sipheka Sisophula theory, Indigenous theory, and Afrocentricity theory to investigate the AmaNdebele worldview, beliefs, and knowledge about the origin of their mathematical artefacts which are used to express culture and ethnic identity. The findings of this study revealed how the AmaNdebele artefacts have both historical origin and cosmic origin. The AmaNdebele culture and identity are well expressed through the mathematical artefacts which are used in different ritual ceremonies and cultural commemorations. This study was underpinned by African philosophies which are the elements of qualitative research and are the basis on indigenous research to guide the researcher to conduct a study that represents the KwaMsiza community, respects their worldviews and adheres to customary laws. The African philosophical underpinnings of the study also assisted the researcher to use an indigenous lense when conducting the study with the KwaMsiza Mabhoko community. The total number of participants in this study was thirty-two, and they were divided into groups based on the study's objectives, which were used to create the data chapters.

The first data chapter used an investigative research design whereby the researcher worked towards gathering knowledge about the AmaNdebele and certain knowledge which she was not familiar with. In order to perform an ethically correct and culturally relevant indigenous method of obtaining and distributing knowledge about the KwaMsiza Mabhoko community, the chapter employed an Indigenous-Informed Relational Approach. An indigenous research paradigm was used in order to honour

the Indigenous knowledge systems and worldviews of participants. The indigenous research paradigm allowed the researcher to see the research process as a sacred pursuit of knowledge. Both the Indigenous-Informed Relational Approach and the indigenous research paradigm informed the entire study. Eight participants were sampled using an expert purposive sampling procedure. Data was collected using focus group interviews. Data analysis was performed through a thematic analysis, where various themes and an emerging theme was identified. The results for this chapter indicate that according to the Ndebele oral history, the use of mathematical artefacts existed at the origins of the AmaNdebele and that means the artefacts are older than the 16th century instead of what has been claimed by many scholars. Over time, the AmaNdebele mathematical artefacts have been transformed and developed. The first major transition occurred in 1883 when the AmaNdebele were defeated by the Dutch Boers in a war. That does not mean the artefacts did not exist before, but they have developed and evolved tremendously.

The second data chapter utilized an investigative research design for the researcher to investigate the cosmic genesis of AmaNdebele mathematical artefacts. The sampling size consisted of six participants who were selected using an expert purposive sampling procedure. The data collection tool for this chapter was semi-structured in-depth interviews. The data was also subjected to thematic data analysis to produce themes. The findings of this chapter show that the utilization of mathematical artefacts was influenced by the Ndebele spirituality, belief systems and religion. The findings indicate that the AmaNdebele received instructions from their supreme beings to use mathematical artefacts as part of their cultural expression and identity. The Supreme beings, according to the AmaNdebele worldview, guides and instructs humans on how to live. The meanings of the geometric shapes are also explained in the chapter, and it is said that the meanings are impacted by their religion, which is the foundation of AmaNdebele's ways of living, doing, and being.

The third data chapter of this study used an ethnographic research design whereby the researcher spent a certain period of time with the participants and also in the environment of the AmaNdebele. As a Ndebele by birth, she has also attended activities held in surrounding areas to understand the cultural identity expressed through mathematical artefacts. The focus group interviews were conducted with ten members of the KwaMsiza Mabhoko community. As a result, the researcher was able

to employ a convenient sampling procedure. The tool for this chapter was piloted in the Mpumalanga Province and the KwaMhlanga surrounding areas, where Ndebele people who practice cultural activities live. The results of this chapter indicate that mathematical artefacts play a major role in ethnic identity and cultural expression. AmaNdebele mathematical artefacts are expressed during ritual ceremonies and during commemorations. Both men and women take part in ritual ceremonies and commemorations. However, women who are the custodians of Ndebele mathematical artefacts, express them more as compared to men. They are responsible for mural art and wear sophisticated beaded attires that reflect geometric shapes. The detailed beaded attires worn by AmaNdebele women differ according to age, status, and level. Men's attires are also worn according to status, age, and level.

The fourth data chapter of this study utilized two research designs. The first was an exploratory research design that allowed the researcher to explore how AmaNdebele entrepreneurs protect and preserve mathematical artefact knowledge. The second design was the investigative research design which was used to investigate existing legal documents which advocate for the protection and preservation of Indigenous Knowledge Systems. Eight women with expertise and experience made up the sample size thus purposive sampling were utilized as a result. The tool that was utilized for this data chapter was in-depth interviews. Methods that were used in this chapter were separated into two. The first was interviews with elderly women who have mastered strategies/art of preserving and protecting the knowledge of AmaNdebele artefacts. The Second was the qualitative document analysis whereby the researcher analyzed existing documents on the protection and promotion of Ndebele crafts and other indigenous artworks. The findings of the study demonstrate that AmaNdebele entrepreneurs conserve mathematical objecobjectledge via a variety of strategies created locally. Some include selling their artefacts and painting their house to appeal to tourists. However, there have been worries voiced regarding the government's neglect of their area, which has been designated as a national heritage site. They argue that the government is not doing its utmost best to preserve IsiNdebele artistic works hence their national heritage sites are losing value and tourists.

They feel that if the government continues to ignore Ndebele artefects, people will be deterred from practicing them. As a method of preservation, they advise that this knowledge becomes part of formal school content/curriculum. The documents

reviewed in this chapter demonstrate South Africa's success in preserving indigenous knowledge systems. Many communities, however, are still unsure of their rights when it comes to indigenous knowledge. This is one of the reasons the Department of Science and Technology established the National Indigenous Knowledge Office (NIKSO) to educate communities about intellectual property rights, benefit sharing agreements, and how to create wealth and employment using their indigenous knowledge.

Key words: Artefacts; Mathematics; AmaNdebele; origin; cultural identity; Mabhoko war; KwaMsiza; History; philosophy

DEDICATION

This research is dedicated to all IsiNdebele speaking people who strive tirelessly to maintain, promote, develop, and safeguard their culture. Their commitment is what has allowed the AmaNdebele culture to develop and be known worldwide.

DECLARATION

I, Monicca Thulisile Bhuda declare that the dissertation hereby submitted for the degree of Docter of Philosophy in Social Science with Indigenous Knowledge Systems at the North-West University is my own original and independent research work. The thesis was carried out under the supervision of Dr.M Koitsiwe and Dr. Z Zulu. I have, not previously submitted this thesis or any part of it, for any degree or examination at another Faculty or University. The research work reported in this thesis does not contain any person' s data, pictures, graphs or other information unless specifically acknowledged as being sourced from those persons.

Signed at **North West, Mafikeng** **Date: 18/03/2022**

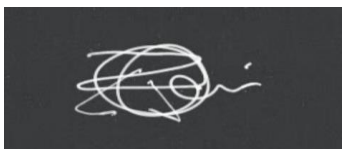
Monicca Thulisile Bhuda (Candidate)

Signature

As the candidate's promoter, I agree to the submission of this thesis.

Signed: **Date: 21/03/2022**

Dr. M Koitsiwe (Promoter)



Signed: **Date: 21/03/2022**

Dr. Z Zulu (Co-promoter)

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I would like to express my gratitude to everyone who has helped me throughout the study process. People close to me constantly reminded me of my skills and their words of support kept me going on days when I doubted my abilities. Even throughout the difficult periods of Covid-19, the creator of the universe gave me the strength to continue with the research endeavour. I am grateful to my family for their prayers and unwavering faith in me. I have had to overcome several obstacles, including being unwell and being involved in a small vehicle accident. My family, particularly my grandmother Sarah Moshoaliba and Mother Ouma Moshoaliba, were there for me every step of the way, giving me the courage to continue with my studies. Every time I felt like giving up, my grandmother would say, "I want you to wear the red gown before I leave my child," and those words have given me confidence.

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Dr. M Koitsiwe and Dr. Z Zulu, my promoters, deserve special gratitude for their unwavering support. Dr. M Koitsiwe has also assisted me with my publishing attempts and conference presentations. I would want to express my gratitude to my mentor, Dr. P. Bernard, who has been monitoring my development and Prof. V. Msila, with whom I have been consulting throughout my post-graduate studies. I would want to express my appreciation to North-West University for allowing me to begin my PhD program in June 2019. I began my academic journey in 2013 when I enrolled in the Bachelor of Indigenous Knowledge Systems programme at North-West University Mafikeng campus, and because of my dedication and commitment, the IKS centre, which is part of the Faculty of Natural and Agricultural Sciences, invested in me as a future established academic. My journey to becoming an academic has begun, and I never imagined I would be able to get to this point in my life.

My biggest motivators were my friends, Dr. M.D Saurombe, who received her PhD in 2017 at the age of 23 and Dr. Z.Z Khumalo, who received her PhD in 2019 at the age of 27. I stayed with them for around three years, and it was during that time that I was inspired by them. These were young black girls who were my contemporaries and had not put up any hurdles in their academic careers, in my opinion. I had seen their hardships and triumphs, and I knew they had put in a lot of effort to become doctors. They have shown me that anything is possible, and I have taken a risk and clung to my dream. I owe everything to my family, and I hope my late father, who died when I was just four years old, sees me and is proud of me. I hope my mother, who gave birth to me at the age of 15, is proud of me. My mother endured a lot of talk due to having a baby as a teenager, so she named me *Thulisile*, which means "kept them quiet," and I hope I keep those who are against me quiet as well. The road to success and happiness is still ahead of us, *Aluta continua*!

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LIST OF ABBREVIATIONS AND ACRONYMS

AIK	African Indigenous Knowledge
CBD	Central Business District
DSAC	Department of Sport, Art and Culture
DST	Department of Science and Technology
ESRF	Economic and Social Research Foundation
FNASREC	Faculty of Natural and Agricultural Sciences Research Committee
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
IPLA	Intellectual Property Laws Amendment Act
IPP	Intellectual Property Policy Act
IRM	Indigenous Research Methodologies
IRP	Indigenous Research Paradigms
NHCA	National Heritage Council Act
NHRA	National Heritage Resources Act
NIKMAS	National Indigenous Knowledge Management System
NIKSO	National Indigenous Knowledge Systems Office
NRS	National Recordal System
NWU	North-West University
RSA	Republic of South Africa
SMME	Small, medium and micro-enterprises
TK	Traditional Knowledge
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WHS	World Heritage Site

CONFERENCE PRESENTATIONS, RESEARCH PUBLICATIONS, TELEVISION AND RADIO INTERVIEWS EMANATING FROM THE STUDY

The following are some of the sections of this study that have been presented and highlighted on various platforms:

Conference presentations

- Bhuda, M.T (2022). The integration of ethnomathematical knowledge in the foundation phase: A step towards the decolonization of education in South Africa. Paper presented at an international Conference on the transdisciplinary search for innovative approaches in the integration and dialogue among indigenous knowledge systems and epistemologies, Johannesburg, South Africa, 20-23 February 2022
- Bhuda, M.T & Marumo, P. (2021). Ubuntu Philosophy, a foundation for indigenous research: A contribution to the indigenizing and decolonization of education in South Africa. Paper presented at International Conference on Legislature and Democratic Consolidation in Africa in the 21st Century, University of Lagos, Nigeria, 28-30 April 2021
- Bhuda, M.T. (2021). The impact of covid-19 in South African basic education: Why there is a need to indigenize education. Paper presented at Havilah Glo International Online Conference on African states and the scrambling for the covid-19 vaccine in the 21st century, Johannesburg, South Africa, 30-31 March 2021
- Bhuda, M.T, & Koitsiwe, M. (2021). The challenges of practicing rites of passage by Southern Ndzundza Ndebele during covid-19: Can male initiation schools operate during covid-19? Paper presented at Havilah Glo International Online Conference on African states and the scrambling for the covid-19 vaccine in the 21st century, Johannesburg, South Africa, 30-31 March 2021
- Bhuda, M.T, & Koitsiwe, M. (2021). The effects of closing the tourism sector during the covid-19 outbreak: The challenges encountered by Southern Ndebele crafts entrepreneurs. Paper presented at Havilah Glo International Online Conference on African states and the scrambling for the covid-19 vaccine in the 21st century, Johannesburg, South Africa, 30-31 March 2021
- Bhuda, M.T. (2020). The Role of Art in Sustaining the Livelihoods of Ama-Ndebele Women in South Africa. Paper presented at Havilah Glo International Online Conference on Implications of COVID-19 on Gender and Behaviour in Africa, Ile-Ife, Nigeria, 18-19 September 2020
- Bhuda, M.T. (2020). The Ndebele Indigenous Games Pertinent to Primary School Mathematics Learning: Why Indigenous Games are a Vital Tool for Mathematics Teaching and Learning during Covid-19. Paper presented at Havilah Glo International Online Conference on Implications of COVID-19 on Gender and Behaviour in Africa, Ile-Ife, Nigeria,18-19 September 2020

- Bhuda, M.T, & Saurombe, T. (2019). Integration of Ethnomathematics in the foundation phase: A case of indigenising maths teaching and learning. The 5th international conference of AASIKS in University of Venda, South Africa, 23rd -25th October 2019,

Published accredited research linked to the study

- Bhuda, M., & Koitsiwe, M. (2022). The Importance of Underpinning Indigenous Research Using African Indigenous Philosophies: PerspectivesFrom Indigenous Scholars. In *Handbook of Research on Protecting and Managing Global Indigenous Knowledge Systems* (pp. 223-248). IGI Global.
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- Bhuda, M.T & Marumo, P. (2021). The Ndebele Indigenous Games Pertinent to Primary School Mathematics Learning: Why Indigenous Games are a Vital Tool for Mathematics Teaching and Learning during Covid-19. In *Proceedings on the Conference on the Implications of Covid-19 on Gender and Behaviour in Africa*.
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CHAPTER 1: INTRODUCTION TO THE STUDY

Background

There's adequate proof, which appears that Africa is home to the world's most reliably known utilization of measuring and mathematics, certifying the mainland as the root of both fundamental and advanced mathematics. For thousands of years, Africans have been utilizing numerals, algebra and geometry in everyday life. This clarification is maintained by Gerdes (1995) who expressed that in reality, proof appears that most of those disclosures came thousands of years after comparable African advancements. Africa is home to the world's earliest form of mathematical thinking and the primary known use of measuring and calculation, affirming the continent as the origin of both fundamental and advanced mathematics. Advanced mathematics can be traced from the Nok civilizations of West Africa to Buganda in the East, from the Great Kongo people of central Africa to the Mutapa, the domain in the South (Collett & Styne, 2017).

"Africa Counts," by Zaslavsky (1973), is a ground-breaking work of study in the field of mathematics history south of the Sahara. Her book is described as "a preliminary overview of an endless field foreseeing examination" (1973, 6). Her assignment was not a straightforward one: it confronts "the insufficiency of effortlessly open fabric... ", she had to look "the writing of numerous disciplines - history, financial matters, ethnology, human studies, palaeontology, etymology, craftsmanship and verbal convention - ..." (1973, 6). She utilized a wide point of view on mathematics in her research, which focused on what she refers to as Africa's "socio-mathematics". She emphasizes “the applications of mathematics inside the lives of African people, and, on the other hand, the affect that African institutions had upon the headway of mathematics” (1973, 7). “Socio-mathematics" as a term might be thought of as a proclamation of the term "ethnomathematics" or "African mathematics."

Most mathematical historians merely dedicate a few pages to Ancient Egypt and northern Africa throughout the "Middle Ages." They mostly overlook the history of mathematics in Africa south of the Sahara, giving the impression that it either did not exist or it's not understandable or traceable, or, even worse, that there had been no mathematics at all south of the Sahara. Attitudes towards Africans’ commitment to mathematical sciences will only change once the story that is generally told is

redressed. The narrative must be balanced. Africa is without a doubt the cradle of humankind. Additionally, Gerdes (1995) argues that it is the birthplace of mathematical sciences, and this can be the continent's single greatest contribution to humankind.

Over the past years, scholars have continued to explore mathematical ideas and concepts in African cultures and have drawn examples from artefacts, languages and settlements just to name a few mathematicians such as Gerdes (1994); Zaslavsky (1994) Laridon, Mosimege and Mogari (2005) who have mainly studied symmetries. They have made critical examples of Bakuba (Zaire) raffia pile cloths, on the bronzes of Benin, and on Yoruba adire cloths from Nigeria. Their findings further indicated that African ancient mathematical art can be divided into three categories, namely (a) art related to spirit; (b) art related to man; and (c) ritual display art (Zaslavsky, 1994).

Scholars like Zaslavsky (1994), Hammarström (2010), and Obadan (2019) investigated African mathematics and discovered that African languages employ numeric systems. Numerals are a class of definite words that express quantity, whereas counting is the process of determining the number of components included in a finite set of objects (Mbah & Uzoigwe, 2016). According to their results, African societies such as Yoruba, Igbo, and Igala use numeral systems in their languages (Blaek, 1999). Between their numerals and counting systems, Igbo and Igala share certain similarities and contrasts. Native people established number systems represented through these ancient languages, which date back to the 8th and 9th centuries.

Studies on African mathematics provide sufficient proof of mathematics ideas and concepts that are part of several African cultures and have separate roots. Many academics refer to the works of Zaslavsky (1973), Gerdes (1994), Eglash (1999), Mosimege (2012), and Mawere (2014) while researching the origins of mathematics in African societies. The aforementioned scholars have made commendable efforts to investigate mathematical ideas and concepts in many civilizations, as well as their origins, demonstrating Africa's early civilisation.

1.2 Problem statement

Non-African researchers have a number of prejudices against African Indigenous Knowledge Systems. The vast majority of them deny the existence of knowledge systems previous to the invaders' arrival. While some have stated that there is no

knowledge of mathematics or science history for instance, despite considerable evidence. Despite the fact that Eglash (1999), a mathematician, attributes the creation of binary number systems and fractal structures to Africans, noting that when Europeans first got to Africa, they deemed the architecture considerably disordered and hence primitive. They never considered that "Africans might have been employing a version of mathematics that they had not really understood yet, and that more investigation and documentation is required.

Similarly, AmaNdebele is not excluded from challenges faced by the rest of the African diverse cultures. This is because, despite the increasing interest in AmaNdebele and their culture, little literature exists on the origin of AmaNdebele mathematical artefacts. Instead, many scholars have been speculating about the origins of Ndebele artefacts and claiming that the mathematical ideas and concepts only existed when they had an encounter with the Boers. Fair attempts on the history of Ndebele mathematical artefacts have been made during the early 1990s by Van Warmelo (1930) who argued that the artefacts might have existed since the 16th century when the Ndebele people arrived in the Transvaal, which is just a speculation. Levy (1990), Mashiyane (2006), Van Vuuren (2012), and Boyd (2017) did research on Ndebele culture and made reasonable attempts to capture the history, mathematical artefacts expressions, and protection of AmaNdebele artefacts. This study does not ignore their contributions but instead focuses on different people to provide more detailed information on the emphasized areas.

However, there are still works on Ndebele culture that ignores the roots of mathematics in AmaNdebele artefacts, giving the impression that this past did not exist or, at the very least, is not verifiable (Meiring, 1955; Schneider, 1986; Ndlovu, 2017). In the 1930s, a photographer named Alfred Martin Duggan-Cronin photographed AmaNdebele artefacts and assumed that the designs had been influenced by colonial shapes and structures. However, just because modern documentation began in the 1930s does not mean that AmaNdebele mathematical artefacts did not exist before the 16th century. When oral knowledge was recorded, it was expected to be taken into account as valid information, but many studies failed to do so. Because of these misrepresentations, an indigenous study like this exists to provide factual information.

To avoid further misinterpretation, particularly in academia, rigorous documenting and safeguarding of AmaNdebele tacit knowledge is required. Studies like this one conducted by indigenous scholars using an indigenous worldview can help achieve this.

Furthermore, existing legal documents that protect the AmaNdebele culture outline how this can be performed in detail. However, the government has not created sufficient outreach programs and platforms to engage AmaNdebele on how they can go about protecting their indigenous knowledge while generating wealth through that knowledge. Such education would prevent exploiters from taking advantage of AmaNdebele art custodians. This research exists to examine current legal instruments preserving Ndebele knowledge, as well as existing government measures to manage knowledge with the participation of knowledge holders.

Nonetheless, Gerdes (1995) deserves credit for making a sincere effort to investigate the origins of mathematics in Africa, using Ndebele beadwork and mural art as crucial examples. His findings were general but important, and they need to be investigated further, which is what this study aims to do. The study asks, "Where do AmaNdebele mathematical objects in KwaMsiza, Mabhoko community originate?" based on the found gaps.

1.3 Rationale of the study

This study makes a two-fold contribution to the field of Indigenous knowledge systems and indigenous research. The first is in terms of Indigenous knowledge systems preservation, protection, and dissemination through research. The second contribution is the importance of proper methodologies for Indigenous research.

1.3.1 Preservation and protection of Indigenous Knowledge Systems

African people developed their own way of living, doing and being. Their worldviews constitute how they live their lives. Since time immemorial, African indigenous people have developed their own knowledge systems which they have tested over a period, have had trials and errors and developed methods of preserving, transmitting, disseminating and protecting for the future generation. However, this knowledge is tacit and needs to be documented through research (Khupe, 2014). Therefore, this research intends to record the indigenous knowledge of AmaNdebele to conserve it

and to make it available to AmaNdebele and people interested in learning about the Ndebele culture.

1.3.2 Aligning methodologies for indigenous research

Most research on African cultures overlooks the role played by the community and respect that needs to be shown towards African worldviews. Scholars who have done research on African cultures have often excluded themselves from the research and treated their participants (community) as objects that they have been experimenting on (Khupe, 2014). In most cases, these researchers critique and question the African worldviews, calling them primitive, mythical, and superstitious. Therefore, in this study, the community members are the central characters (Kovach, 2009; Chilisa, 2012). The researcher will adhere to the customary laws and respect the knowledge shared by the participants. The researcher hopes to gain an understanding of KwaMsiza Mabhoko community knowledge and the worldview that underpins it by employing several methods appropriate for indigenous research. As a result, the researcher expects that this thesis will serve as a resource for other academics interested in African mathematics, civilisation, Renaissance studies, indigenous studies, and research.

1.4 Research aim and objectives

This study investigates the origin of AmaNdebele mathematical artefacts in KwaMsiza, Mabhoko community, North-West province

The research is guided by the following objectives:

1. To investigate the historical origin of the AmaNdebele mathematical artefacts
2. To investigate the cosmic genesis of the AmaNdebele mathematical artefacts
3. To explore the cultural identity from the AmaNdebele mathematical artefacts.
4. To explore how the AmaNdebele mathematical artefacts have been protected and preserved.

The following research questions guided the objectives of this study:

1. Where do the AmaNdebele mathematical artefacts originate?
2. What is the cosmic genesis of the AmaNdebele mathematical artefacts?
3. How do AmaNdebele artefacts serve as cultural identity?
4. What are the symbolic meanings of AmaNdebele geometric shapes?

5. How is spirituality connected to AmaNdebele mathematical artefacts?
6. What purpose do AmaNdebele artefacts serve?
7. How have the AmaNdebele mathematical artefacts been preserved and protected?

1.5 Significance of the study

The researcher wants to document the knowledge of Ndebele mathematical artefacts through research and preserve it for the next generation. The study aims to have a beneficial impact on AmaNdebele by encouraging people to appreciate and value the importance of indigenous identity; this is especially important in moving on with research to expand or update constructs from prior studies. Considering how colonialism has influenced AmaNdebele ways of thinking and what gets regarded as knowledge can be considered while privileging indigenous identity (Kovach, 2009; Smith, 2012). As a result, the goal of this research is to help the AmaNdebele to conserve and protect their traditional customs and ways of life.

Because mathematics is an important sector for development, the researcher intends to further improve AmaNdebele's indigenous knowledge so that it can be used as a tool for sociocultural change, innovation, and other areas of development. This study will contribute to indigenous research, which aims in promoting African indigenous knowledge systems and contribute towards decolonizing education in South Africa. This study hopes to inspire African scholars to write about their own expertise, using the indigenous lens and conducting research that can influence policy frameworks on Indigenous Knowledge systems.

The current study expects indigenous researchers to work toward decolonizing measures in both professional and personal domains: self-decolonization and decolonization of the research community. Indigenous identity should be valued in the same way that new, affirmative research paradigms and methodologies for indigenous people should be valued by non-indigenous scholars. While non-indigenous scholars cannot identify as indigenous, they can show more compassion for historical and current colonial battles and effect change in the research process, allowing indigenous researchers to use or develop indigenous methodologies (Kovach, 2009; Smith, 2012).

1.6 Personal orientation of the researcher to the study

The researcher was born and raised in Kwaggafontein, a Ndebele people's village in Mpumalanga. From a young age, she was exposed to the cultural practices of the Ndebele people. Throughout her upbringing, she witnesses the sophistication of her cultural practices and got to understand the belief systems of her people. As a young girl, she was interested in knowing more about her culture which resulted in her attending different ritual ceremonies and observing how her paternal aunt does beadwork. The calculations and measurements of how her aunt constructed beadwork made her want to learn more about Ndebele art. Her Master's degree which was completed in 2019 was "investigating the role of ethnomathematics in the cultural life of AmaNdebele women" (Bhuda, 2019: 6). This is when the results of her study stated that Ndebele women use mathematical ideas and concepts (symmetrical geometry) in constructing their art (beadwork and murals).

The completion of the study in 2019 made her see knowledge gaps that needed to be investigated. These knowledge gaps are those of the origin of the Ndebele mathematical artefacts. The researcher believes that her people did not construct mathematical ideas and concepts out of nowhere but rather there is a great spiritual influence. Even though her Master's degree study touched on this aspect, more research needed to be done on Ndebele beliefs, the history of mathematics and worldviews which have an impact on why the Ndebele women use mathematics in their art. This research is important to the researcher because she wants to investigate the knowledge of her people that is perishing and overlooked.

Using an indigenous lens, the researcher has chosen her methodology and axiology based on her indigenous experience and is conducting studies in indigenous knowledge systems that seek to decolonize and shift away from standard research methods. The methods used by this researcher for data generation and analysis, therefore, moved towards research practices, which perceive the realities of the AmaNdebele. The researcher wanted to conduct a study that would be a ritual ceremony whereby she will be a "learner" and not a "knower". She followed appropriate customary law (axiology) that enabled the community to welcome her as one of their own. In this manner, she was able to conduct a study "with" the community instead of "on" the community, making her indistinguishable from the participants.

Following proper protocols (axiology), allowed the researcher to conduct a study with Ubuntu principles with the purpose (teleology) of obtaining knowledge on how her people perceive their reality (epistemology) and what they view as reality (ontology). She wanted to find out how AmaNdebele conceive and consider their universe and whether the universe is the focal point through which they see reality, which influences their value systems and attitudinal orientations (African cosmology). Throughout this process, the researcher had to understand that she does not own the knowledge and that participants had the rights to withdraw from the study anytime they felt violated, marginalized, and undermined (Chilisa, 2012; Khupe, 2014; 2017).

1.7 Delimitation of the study

The AmaNdebele are found in both South Africa and Zimbabwe. The Southern AmaNdebele, which are in South Africa, are divided into two groups which are the Ndzundza and Manala Ndebele. Therefore, the study will limit itself to these two groups because they are known to speak the purer IsiNdebele and are responsible for the globally known beadwork and mural art that reflects symmetrical geometry. The North Ndebele people that are located around Zebediela in the province of Limpopo will not be included in this study (Mashiyane, 2006). The AmaNdebele of Zimbabwe will not be included here, either. It has been proven beyond any reasonable doubt by history that the Zimbabwean Ndebele practice a different culture, and tradition and speak a different language from that of Southern Ndebele. Their inclusion in this study may have a dramatic impact on the results of the report. This study will limit itself to the KwaMsiza Mabhoko community, heritage settlements with people who are still preserving and protecting their indigenous knowledge.

1.8 Organization of the study

This research is divided into eight chapters. The study's first chapter delves into the background of African mathematics. This chapter contains the rationale for the study, the problem statement, the study's aims, and objectives, as well as the study's significance and delimitation. The reader is introduced to the concepts and terms utilized in this study in Chapter 2. It also investigates the history of mathematics on the African continent, as well as studies related to this research. Chapter 3 focuses on the study's African philosophical underpinnings.

Furthermore, the chapter concentrates on the study's conceptual framework, gives a map of the researched area, and provides a brief history of the community as well as an outline of North-West Province to the reader. The historical origin of the AmaNdebele mathematical artefacts is discussed in Chapter 4. Chapter 5 discusses the cosmic genesis of the AmaNdebele mathematical artefacts. Chapter 6 provides the reader with the the cultural identity from the AmaNdebele mathematical artefacts. Chapter 7 explores the preservation and protection of AmaNdebele mathematical artefacts. The reader will find general discussions, conclusions, and recommendations in Chapter 8.

CHAPTER 2: THE ORIGIN AND HISTORY OF AFRICAN MATHEMATICS

2.1 Introduction

Many academics are currently interested in African mathematics, which demonstrates the early life of people and society. Scholars such as Gerdes (1994), Zaslavsky (1999), and Eglash (1999) accept that the portrayal of Africa as an uncivilized continent reliant on Western civilization was entirely false. In fact, Africa has evidence of early mathematical ideas and concepts embedded in their cultural lives. Mosimege (2005) added that critical examples could be drawn from the AmaNdebele of South Africa who use symmetrical geometry in their cultural beadwork and murals art. When it comes to the AmaNdebele, most scholars who have attempted to research the community have never used words like AmaNdebele mathematics or ethnomathematics. Rather, they have noted in their studies that there's evidence of geometry in beaded clothing and murals, but they've never gone into detail about it. Scholars such as Van Warmelo (1930), Levy (1990), Powell (1995), Mashiyane (2006) and Van Vuuren (2012) to name a few acknowledge the ancient history of Ndebele geometry.

This study explores the origins of AmaNdebele mathematical artefacts and their role within the culture from where other scholars left off in their investigations. Therefore, this part of the study will commence by giving the definition of concepts that will be used throughout the entire study and to guide this study. Second, the chapter will focus on the history of mathematics in the African continent. Last, the chapter takes a detour and looks at the shortcomings of studies on the origin of AmaNdebele mathematics.

2.2 Definition of important terms and concepts used in the study

Indigenous knowledge

Indigenous Knowledge (IK) can be defined, according to Emeagwali & Dei (2004), as the “cumulative body of strategies, practices, techniques, tools, intellectual resources, explanations, beliefs, and values accumulated over time in a specific locality, without the interference and impositions of external hegemonic forces.”

Indigenous Knowledge Systems

Indigenous Knowledge Systems (IKS) are a body of knowledge or knowledge systems that indigenous people have long maintained in certain geographical areas (Nyota & Mapara 2008). Indigenous knowledge systems (IKS) are knowledge systems that have evolved independently of and before the emergence of the modern scientific knowledge system in distinct communities. IKS refers to the skills and knowledge that individuals of a community have earned and continue to learn over time.

African indigenous mathematics

African indigenous mathematics refers to mathematical concepts grounded in African cultural traditions, recognizing that all cultures and people have their own techniques and sophisticated reasoning for comprehending and changing their own reality (Eglash, 1999).

African culture

African culture consists of religious beliefs, languages, clothing, living styles, political organization, and all other facets of life are all part of the culture. African culture is described as the sum of African people's way of life, comprising tangible and intangible items, habits, customs, and concepts, as well as the arts, technology, music, literature, theatre, health, drama, and education in the context of this study. “Culture is both stable and dynamic, explicit and implicit, shared and learned, ideal and manifest, covert and overt, organic and supra-organic, corruptible and reforming. An African person inherits a cultural heritage from the preceding generation which they use, add to and pass on to the succeeding ones” (Adegboye & Olagunju, 1996:236-238).

African worldviews

An African worldview, according to Asante (1987), is based on African cultural beliefs, customs, and norms. Khoapa (1980) stated that an African's existential experience is that of a collective being, attempting to understand the world through its interaction with all aspects of the world and with others.

Traditional Cultural Expressions

The work of indigenous peoples and traditional communities are referred to as traditional cultural expressions. “Those expressions that result from the creativity of individuals, groups and societies, and that have cultural content” (UNESCO, 2017).

Origin

The point at which something begins its journey or existence is referred to as its origin. As a result, it refers to the objects or people from whom something is ultimately derived, as well as the causes that operate before the object comes into being (Diop & Cook, 2012).

Identity

Identity is “people’s concepts of who they are, of what sort of people they are, and how they relate to others” (Abrams & Hogg, 1988:2). It is how people and groups describe themselves and are characterized by others based on their race, ethnicity, religion, language, and culture (Herrigel, 1993).

A community

A community is a group of people who connect and support each other, and are bounded by common experiences or attributes, a sense of belonging, and by their physical closeness. In geographical locations or environments, they participate in collective action too (Ahmed & Palermo, 2010).

AmaNdebele

AmaNdebele are a Southern African indigenous people who live in both Zimbabwe and South Africa. They are descendants of the Nguni ethnicity and are descendants of the Bantu people (Jackson, 1969; Mahlangu, 2016).

2.3 Introduction to African mathematics

The term African mathematics derives from a broader concept called ethnomathematics which was established by D’Ambrosio (1985) who is currently known as the father of ethnomathematics. Ethnomathematics tries to study mathematics in its relations with the whole of cultural and social life.” Ethnomathematics is a collection of concepts about the history of mathematics, its cultural foundations, implicit mathematics in everyday life, and mathematics education. As an educational concept, ethnomathematics proposes that the subject of mathematics education be based on the mathematics inherent in the children's culture.

Scholars have attempted to define African mathematics in the past, and they have related it in the following terms:

Indigenous mathematics

Indigenous mathematics is mathematics that starts with indigenous knowledge. This mathematics is tied to indigenous people's ways of doing and being (Lancy, 1981).

Socio-mathematics of Africa

"It is the applications of mathematics in the lives of African people, and, conversely, the influence that African institutions had upon the evolution of their mathematics". (Zaslavsky, 1973: 7):

Informal mathematics

Mathematics that is handed down from one generation to another and learned outside of the regular educational system (Posner, 1982).

Mathematics in the (African) socio-cultural environment.

This is mathematics embedded in African crafts, games and culture. It belongs to the socio-cultural environment and should be integrated in the mathematics curriculum (Gerdes, 1998).

Spontaneous mathematics

Mathematical ideas and concepts are developed by cultural groups' spontaneously (D'Ambrosio, 1987).

Oral mathematics

Mathematical knowledge that exists in various communities and is passed down orally from generation to generation (Kane, 1987).

Oppressed mathematics

According to Gerdes (1994), there are mathematical aspects in the daily lives of people in class societies (e.g., in the countries which were considered of the 'Third World' during colonial occupation) that are not acknowledged as mathematics by the dominant ideology.

Hidden or frozen mathematics

Although, according to Gerdes (1986), the majority of formerly colonized peoples' mathematical knowledge has likely been lost, one can try to recreate or ‘unfreeze' mathematical thinking that is ‘hidden' or ‘frozen' in archaic skills, such as basket manufacturing.

Folk mathematics

Folk mathematics, the mathematics that emerges in each person's working activity but is often overlooked, can be used as a starting point in the teaching of mathematics (Mellin-Olsen, 1986).

The numerous features exposed by the aforementioned preliminary ideas have increasingly been unified under D'Ambrosio's ethnomathematics' broader common denominator. The establishment of the international concept has hastened this process. For the purpose of the study, the term “African mathematics” will be used in order to provide detailed information on mathematical ideas and concepts used in African societies. Many examples of ancient mathematics may be found in African culture, including but not limited to counting, games, symbols, artwork, and sculptures, most of which illustrate bilateral and circular symmetry and integrate geometrical shapes. The following section of this study provides African continental mathematics origin and history.

2.3.1 African continental mathematics origin and history.

Africa is home to the world's earliest known utilization of measuring and calculation, affirming the landmass as the origin of both essential and progressed mathematics. Thousands of years back, Africans were utilizing numerals, algebra and geometry in everyday life. This section focuses on history and origin of mathematics in Africa (Asante, 2000).

2.3.1.1 Measuring and counting

As per Asante (2000), Egyptian mathematics refers to mathematics written in the Egyptian language. Greek began to supplant Egyptian as the composed language of Egyptian researchers during the Hellenistic period. Mathematical research in Egypt continued under the Arab Empire as part of Islamic mathematics, when Egyptian researchers were required to write in Arabic (D'Ambrosio, 2001).

Demortier (2009) mentioned that the foremost extensive Egyptian numerical content is the Rhind papyrus, dated to c. 1650 BC (see figure 2.1). It is a guide for students

learning number juggling and geometry. It also contains proof of other numerical information, such as counting composite and prime numbers; math, geometric, and consonant implies; and oversimplified understandings of both the Sifter of Eratosthenes and the culminate number hypothesis, in addition to range equations and strategies for increase, division, and working with unit divisions (specifically, that of the number 6). It also shows how to solve first-order linear conditions and arithmetic and geometric series (Kittler & Darula, 2008).

Another noteworthy Egyptian mathematical content is the Moscow papyrus, also from the Center Kingdom period, dated to c. 1890 BC (Spence, 2000). It comprises what are today known as word or story riddles, which were clearly created for the purpose of entertaining. One issue is regarded particularly important since it reveals a method for calculating the volume of a frustum (truncated pyramid). According to Demortier (2009), another one is the Berlin Papyrus 6619 (c. 1800 BC) which shows that antiquated Egyptians seem to solve a second-order algebraic equation.

The development of a number system depends upon economic needs. In Africa in which all or most of the necessities of life are produced inside the community, there is a small requirement for a broad reckoning system. The names of numbers are regularly associated with the objects to be numbered (Campbell & Folk, 1991). Delius & Schoeman (2010) contended that from 3000 BC the Mesopotamian states of Sumer, Akkad and Assyria, Antiquated Egypt and Ebla began using arithmetic, algebra and geometry for purposes of tax assessment, commerce, trade and also within the designs in nature, the field of astronomy and to record time/formulate calendars (Delius & Schoeman, 2010). The British Museum holds the majority of the Rhind papyrus, as well as a copy of a text from two centuries earlier made around 1650 BC.

Rhind Mathematical Papyrus

Figure 2. 1: Oldest Egyptian numerical system called Rhind Mathematical Papyrus (Chace, 1927).

2.3.1.2 Number systems

One of the first objects demonstrating an inclusion with counting was discovered a few years ago near Ishango, on the shores of Lake Edward in the Democratic Republic of the Congo, at an open-air site within Virunga National Park, near the town of Goma. It could be a bone device tool, with a chunk of quartz placed in a limited depth in its head and notches arranged in clear patterns. It was created sometime between 9000 and 6500 B.C. This bone appears to represent proof of early civilization and advanced number systems in Africa (Pletser, 2012).

Moreover, Pletser (2012) stated that the three columns of asymmetrically clustered notches suggest that the tool was intended to be practical rather than beautiful. It is possible that the Ishango grouping was employed to create a number system. The middle column has 3 notches at first and then doubles to six. The procedure is repeated for the number 4, which doubles to 8 notches, and then reversed for the number 10, which is cut in half and reduced to 5 notches. These numbers, then, are not completely random; rather, they imply a basic comprehension of multiplication and division by two principles. As a result, the bone may have been utilized as a counting tool for basic mathematical operations (Adhikari & Mehera, 2018).

In addition, Kamalu (2021) highlighted that the number of notches on either side of the middle column could suggest greater counting ability. All of the numbers in the left and right columns are odd (9, 11, 13, 17, 19 and 21). The prime numbers between 10 and 20 (which constitute a prime quadruplet) are all in the left column, whereas the numbers in the right column are 10+1, 10-1, 20+1, and 20-1. Each side column's numbers sum up to 60, while the centre column's numbers add up to 48. Both of these numbers are multiples of 12, implying that they know how to multiply and divide (Lumpkin, 1997). Marshack (1991) microscopically studied the Ishango bone and found that it could be a six-month lunar calendar. According to Zaslavsky (1999, 2004), this could indicate that the tool's developer was a woman who was tracking the moon phase in relation to her menstrual cycle. Virunga National Park was included in the World Heritage List in 1979 (number 63) and in the List of World Heritage in Danger in 1994. According to the typical requirements of deposition and exhibition in a modern museum, the Ishango bone is carefully protected.

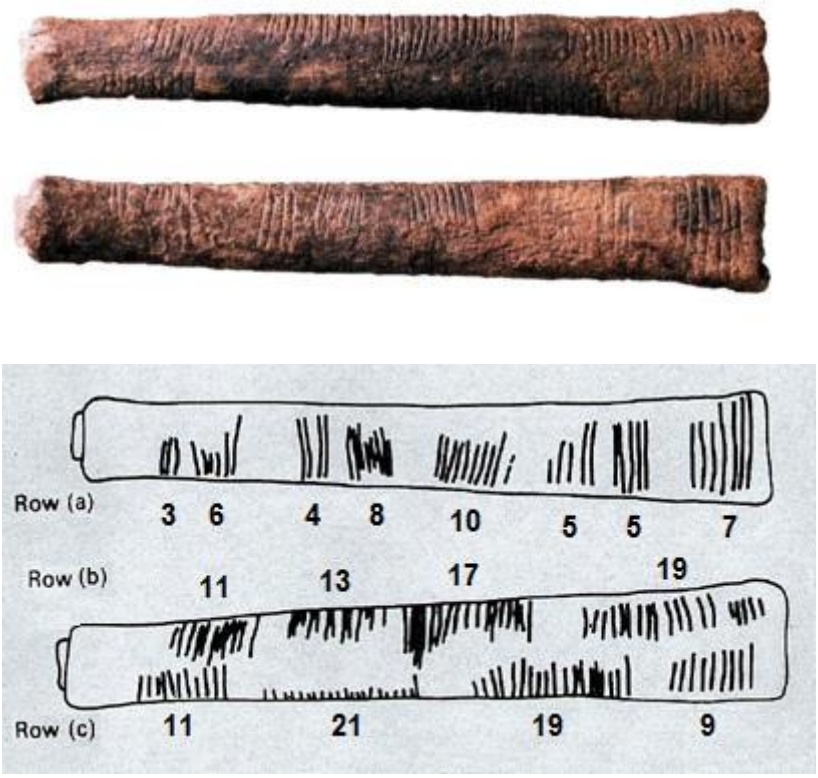


Figure 2. 2: detailed drawing of the Ishango bone by De Heinzelin (1957).

The Lebombo bone shown in figure 2.3, which is a bone instrument constructed of a baboon fibula with engraved marks unearthed in the Lebombo Mountains between South Africa and Swaziland, is similar to the Ishango bone. Variations in the section of the notches show the employment of various cutting edges, which the bone's explorer, Beaumont (1973) believes is evidence that they were formed during ritual participation, similar to other markings found all over the world. According to 24 radiocarbon dating, the bone is between 44,200 and 43,000 years old. This is a much older bone than the Ishango bone, which is frequently confused (Bangura, 2011).

Burbanks et al (2020) stated that other notched bones date back 80,000 years, although it is unclear if the notches are purely cosmetic or serve a useful purpose. Because keeping track of menstrual cycles necessitates a lunar calendar, the Lebombo bone's 29 notches suggest, it may have been employed as a lunar phase counter, in which case African women may have been the first mathematicians. However, because the bone is visibly shattered at one end, the total number of notches may or may not be 29. There has been no consistent notch tally in the cases of other notched bones discovered since, with several being in the 1–10 range. This looks like a calendar used by the area's early men, who were from the San clans of Namibia.

These are the earliest unmistakable signs of modern human conduct. Bone tools were already existing 75,000 years ago and were utilized in San civilization, according to early San material culture evidence (Ezeanya, 2014).

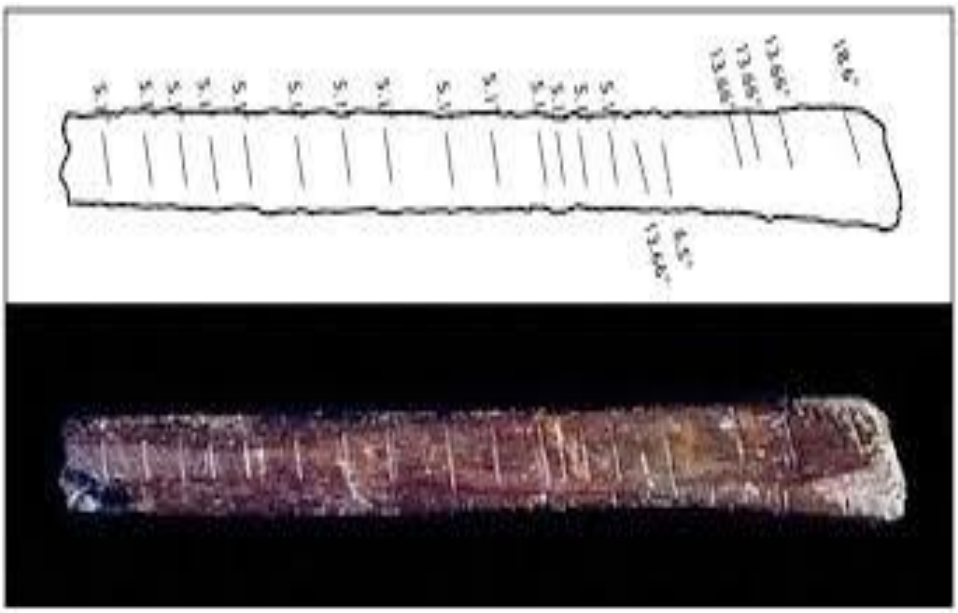


Figure 2. 3: Detailed drawing of Lebombo bone by Kapcar (2011).

Based on the above mentioned, it is clear that Africa's people use a wide range of techniques that represent numbers. Africa's nations employ a variety of numerical systems, including the following:

- Systems Based on Five and Twenty

Egyptian mathematics is well known of two papyri and auxiliary Greek and Roman sources. There are over 100 mathematical problems reach from approximations for the area of a circle or the volume of a truncate pyramid and of a barrel (or of a split circle), to other standard numerical problems still instructed in school today. In the same notion, Wenke (1991, 2009) argued that their multiplication strategy is assumed to have spread from Greece to Russia, the Center East and back to Ethiopia, a way so unforeseen one can ponder how this will be substantiated. Besides, tailors in West Africa would have utilized it in mental calculations, until as of late (Delius & Schoeman, 2010).

Zaslavsky (1994) who conducted studies on African number systems stated that the names of numbers in numerous languages gives clear evidence of finger counting, and at times, of toe-counting. The word for five most of the time is equivalent to "hand,"

six is "hand and one," at that point "hand and two, etc, to ten, which might be an independent word, or might be "two hands." Ten is trailed by ten plus one, etc to fifteen, which might be "two hands in addition to one hand," or "ten in addition to one hand," or even an autonomous word, as in the language of the Diola clan of Portuguese Guinea, where the word signifies "to bow" (Zaslavsky,1994). Proceeded by including one, two, and so on to the word for fifteen, until we arrive at twenty. This word in certain language implies in a real sense "man complete." In the Banda language of Central Africa the word for fifteen signifies "three fists," and for twenty, "take one person" (Eglash, 1999).

A similar strategy is then utilized once more, adding to the word for twenty to form the numerals from twenty-one to thirty-nine (Zaslavsky, 1994). Forty is expressed as "two men complete," and one hundred is "five men complete"; as such, the entirety of the digits on the hands and feet have been tallied five times. This is the essential type of a quinquavi gesimal system (based on five and twenty), in which five is the essential base. It is found in numerous languages of the Sudan district of West Africa, Ibo and Ibibio of Nigeria, the Diola, Balante, Nalu, and Banhun of Portuguese Guinea, the Vey and Kru of Liberia just as the Nuba clan of the eastern Sudanic region (ibid,1994).

- Systems Based on Five and Ten

The Wolofs, Fulani, Soninke, and other tribes of western Sudan, as well as the Kpelle clan of Liberia, adopted the quinary-denary system. The number system of the local people is depicted in a magnificent book on the teaching of descendants of the Kpelle clan in the field of mathematics. Gay and Cole (1967) affirmed that it has a primary base of 5 and a secondary base of 10. The number twenty is represented as two tens. A few words are synonymous with Mandingo. The majority of mathematical operations are carried out with the aid of heaps of stones, and people become extremely adept at seeing numbers in this manner (Zaslavsky, 1973).

2.3.1.3 Number taboos

The compounding of the names for seven, eight, or nine is a curious phenomenon; 7 = 6+1, 9 = 8+1, as among the Mandyakos of western Sudan, whereas 7 = 6+1 and 8 = 6+2 in the Ga language of the Ivory Coast tidal ponds. This astonishment could have been caused by a taboo against mentioning particular figures. Among Kongo and Mossi, the number seven was particularly ominous (Zaslavsky, 1999). Zaslavsky

(1999), on the other hand, suggested that the taboo could be addressed in a different way. The speaker just produces the prohibited number signal, while the audience creates the signal. As a result, the threat is separated between them. Many African nations believe that counting people, domestic animals, or valuables is a bad idea since it puts them in danger. Adults in Liberian experiments with the Kpelle people were unclear when asked how many people or houses there were in their village. They were adamantly opposed to counting living animals (ibid, 1999).

2.3.1.4 Mental mathematics

The mancala family of African system games are among the most experienced mind games, dating back to the 7th century and traced to Egypt, demonstrating once again the ancient civilization of African people (Bell & Cornelius, 1988). Local names include boa, okweso, ayo, (igi)- soro, and others, as well as versions with two to four lines and six to fifty openings in a row (see figure 2.4). In Uganda igisoro is frequently played by indigenous communities. Uganda is a member of the Universal Declaration of Human Rights and the International Covenant on Economic, Social, and Cultural Rights, demonstrating its commitment to cultural rights on the international stage. Uganda has additionally accepted the UNESCO Conventions on Tangible Cultural Heritage (Convention of 1972), Intangible Cultural Heritage (Convention of 2003), and Cultural Diversity and Expressions (Convention of 2005). Five of Uganda's cultural features have been enshrined in the 2003 Convention. “The value of cultural identity and the existence of 65 indigenous tribes are recognized in Uganda's 1995 Constitution. The Government of Uganda commits to ensuring that the people's social and cultural well-being is respected, as stated in Objective xxiv (a) of the 1995 Constitution, which states that the State shall promote and preserve cultural values and practices that enhance Ugandans' dignity, as well as encourage the development, preservation, and enrichment of Ugandan languages” (The cross-cultural foundation of Uganda, 2016:3).

The laws of the game change, and it is thus possible to study societies not in terms of their language or dialects, nor terms of their customs or beliefs, nor in terms of their brilliant articulation of music, but in terms of their way of thinking (Bikić & Vuković, 2010; Mkondiwa, 2020). In fact, there are over 200 different variations of this "count and capture" game played across Africa, each with somewhat different rules. In North and West Africa, two rows of pits are prevalent; in Ethiopia, three rows are popular;

and in East and Southern Africa, four rows are prevalent. There are "stores" at the end of each board in some games, but not in others (Bayeck, 2018).

Using Nigeria as an example, Ndukwe et al (2014) stated that the Dara game (see figure 2.5) is a two-player abstract strategic board game played in a number of West African countries. It is played by the Dakarkari people of Nigeria. It is a game that has been played for hundreds of years and has a few different names (Dera or Doki). It contains intricate game boards as well as being able to be played in the sand. The most typical way to play is with a normal 5 x 6 rectangle and 12 pieces for each player to arrange on the board, which may clearly be drawn by hand. According to UNESCO (2017), Nigeria's commitment as a state party to the Convention on the Protection and Promotion of the Diversity of Cultural Expressions has been demonstrated in its implementation of the Convention by providing the necessary administrative, legal, and conducive environment for government agencies and non-governmental organizations to achieve the Convention's goals (NGOs).” Nigeria has always had a Cultural Policy/mechanism in place that attempts to conserve and promote the diversity of the country's cultural expressions” (UNESCO, 2017:1).

Butterfly (Gulugufe in Tonga language) is a nicely designed board game found in Mozambique, which is located in Southern Africa. Ondenyi (2020) argued that the game's simplicity enables popular pencil and paper versions where two equal-sized triangles are glued together (see figure 2.6). The game is played identically to checkers, with the exception that the jumping and movement rules now take place at the 19 intersections. The game also encourages children to consider paths and networks (Rosa & Orey, 2016). In 1982, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the World Intellectual Property Organization (WIPO) published the Model Provisions for national laws on the protection of expressions of folklore against illicit exploitation and other prejudicial actions. The Model Law establishes protection principles, the context of the subject matter, the authorized uses, the method of obtaining authorization, the exceptions and limitations to authorizations, the moral rights attached to copyright, civil and criminal sanctions, the designation of the competent authority to administer copyright, and the protection of folklore expressions (Nwauche, 2010).

Figure 2. 4: Igisoro mathematical game of the mancala family (Wikipedia, 2009).

Figure 2. 5: Dara Nigerian mathematical game of the Mancala family (Wikipedia, 2019).

Figure 2. 6: The Gulugufe (Butterfly) Mozambique mathematical game of Mancala family (Wikipedia, 2019).

Further mathematical characteristics of traditional games, according to Zaslavsky (1973), could be crucial in reconstructing the history of mathematical thought in Africa. Doumbia (1989) and her colleagues at the Mathematical Research Institute of Abidjan (Cote d'Ivoire) conducted groundbreaking research on traditional African games. Their research reveals that the rules of particular games suggest an empirical understanding of probability, a discovery that will undoubtedly spur more research.

2.3.1.5 African symmetry

Symmetry as explained by Washburn (1986, 1) is a “type of order with specific geometric parameters. As a mathematical measure, it has proved useful for the classification and comparison of patterns in cultural materials. Investigators have been able to study more systematic consistencies and changes in temporal and spatial aspects of design styles and to relate these shifts to other patterns of activity in a given culture”. The following examples from African cultures have been made for the purpose of this section:

The Asante Kente cloth

The Asante Kente which is amongst cultural expressions protected by Ghana’s Copyright Act of 2005 is a woven cloth from the 11th century. It is distinguished by its vibrant, multi-coloured patterns, geometric shapes, and dramatic motifs (Ofori-Ansa, 2009). Kente is a derivative of Kenten, the Twi word for the basket; it also refers to the ‘creative, thoughtful, or designer's weaved cloth,' as Asamoah-Yaw (1992) explains it. Since at least 1817, visitors have been drawn to Asante Kente as a cloth of opulence and ostentation, with an exorbitant price and enormous size and weight (Avins & Quick, 1998). Gender-specific Kente cloth is manufactured and worn. Kwakye-Opong (2014) stated that textile art, particularly in West Africa, could be utilized to demonstrate more symmetry and patterns, while the loom and weaving technique is a good example of engineering mathematics in and of itself.

Figure 2. 7 : The Asante Kente mathematical cloth (Davenport, 2020).

Frafra symmetrical wall paintings

The Frafra are a voltaic people who live in north-eastern Ghana and are made up of three ethnic groups that are culturally and linguistically related: the Gurensi, Tallensi, and Nabdam (Zaslavsky, 1994; 1999). Women have specialized in non-figurative, rectilinear, and symmetrical wall painting, which is thought to have existed since 1100 AD. The repetition of a single theme or pattern inside a horizontal or sometimes vertical register is the most prevalent ornamental scheme. The wall is frequently separated into two horizontal registers by a narrow band or a pattern known as yidoor, which consists of a series of painted and/or incised parallel lines. There are around seventeen well-known and widely utilized themes in total. Sheldon (2017), on the other hand, suggested that among the Frafra of northern Ghana, there is also a recognition of creative ability as well as technical and stylistic expertise.

Frafra wall painting which is protected by Ghana's Copyright Act of 2005 exhibits highly creative and individualistic treatment (Boatbil & Guure, 2014). Ghana became the first country to extend that framework to include a domestic tax on folklore in 2005 when it passed its copyright legislation, which implemented such protection for folklore. The 2005 law intended to impose harsher penalties for the unauthorized use of Ghanaian folklore in other countries (Ludewig, 2009).

Figure 2. 8: The Frafra of Ghana painted house (Smith, 1973).

Bamileke symmetrical masks

McNaughton (1991) wrote that the Bamileke are part of the Cameroon Grasslands, which is a broader cultural area. There are various smaller peoples within the Bamileke complex who are loosely related and share many characteristics while maintaining unique identities. The Bamileke came from Mbam, which is currently occupied by the Tikar, in the north. Scholars such as Probst (2007) and Forni (2016) who have conducted research on the Bamakile people stated that they make symmetrical elephant masks out of beads. The Bamileke masks are manufactured in the honour of the king (Fon) and perhaps significant chiefs. They have existed since the 17th century and are used as part of culture and history (see Figure 2.9). The artefact is revered as a powerful object, and it is presented during key rituals and ceremonies to honour and memorialize the current Font's royal predecessors. Masks have colourful beads and symmetrical patterns, both of which are indications of great intelligence (Stepan, & Hahner-Herzog, 2005). The UNESCO Convention for the Protection of the World Cultural and Natural Heritage was ratified by Cameroon in 1982. This legal international instrument requires the government to ensure the identification, protection, preservation, and development of cultural and natural assets for future generations.

Figure 2. 9: The Bamileke symmetrical elephant mask. (The Museum of African art, 2021).

2.3.1.6 African fractals

Fractals can be found in African villages nowadays as well as in ancient times. A fractal is an item that is self-similar in appearance. The length of a coastline measured using multiple-length rulers is the best illustration of a fractal. The Coastline Paradox states that the shorter the ruler, the longer the length measured. The basic concept underlying these fractals was not mathematical, but rather natural. The basic concept underlying these fractals was not mathematical, but rather natural (Eglash et al., 2011).

Africans saw nature's symmetry and utilised it to create fractal villages. They were aware of and comprehended the concept of a rectangle within a rectangle. Fractals are used in architecture according to Sala (2006), as well as art and religion (i.e., the Ethiopian Cross). They used this principle for constructing communities and palaces. Although there's not much information about these fractals and patterns other than the fact that they exist, it demonstrates how things change. Much like how many maths concepts arose from nature and culture.

Ba-ila fractal settlements

The Ba-ila settlements in southern Zambia which are protected through the National Heritage Conservation Commission Act of 1989, are gigantic circles with fractal characteristics, such as rings within rings. The settlements were constructed in the 16th century by highly trained artisans who also worked for the ruler. Smaller rings, which are livestock pens, make up the structure (corrals). Smaller rings are made up of solitary cylinder dwellings and storage spaces. It's a ring made up of rings. A miniature village, where the chief has extended family, is located toward the back of the hamlet (Zappulla, 2013).

Eglash (1999) noticed that the village has a population of roughly 2000 people and approximately 250 huts. The family dwelling quarters are located toward the back of each coral. The sacred altar is located in the back of each dwelling. The chief's family ring, as a logician would put it, is to the entire town what the altar is to the house. They see this as a repeating functional position inside the settlement at various scales. The chief's relationship with his people is defined by the word *kulela,* which means, to dominate. Nevertheless, this is merely a secondary meaning; the primary meaning of *kulela* is to nurture and cherish. The chief is referred to as the community's father in the same way that a mother is referred to as the father of her child. At all scales, this linkage is mirrored in family and spiritual bonds, and it is architecturally documented through self-similar architecture.

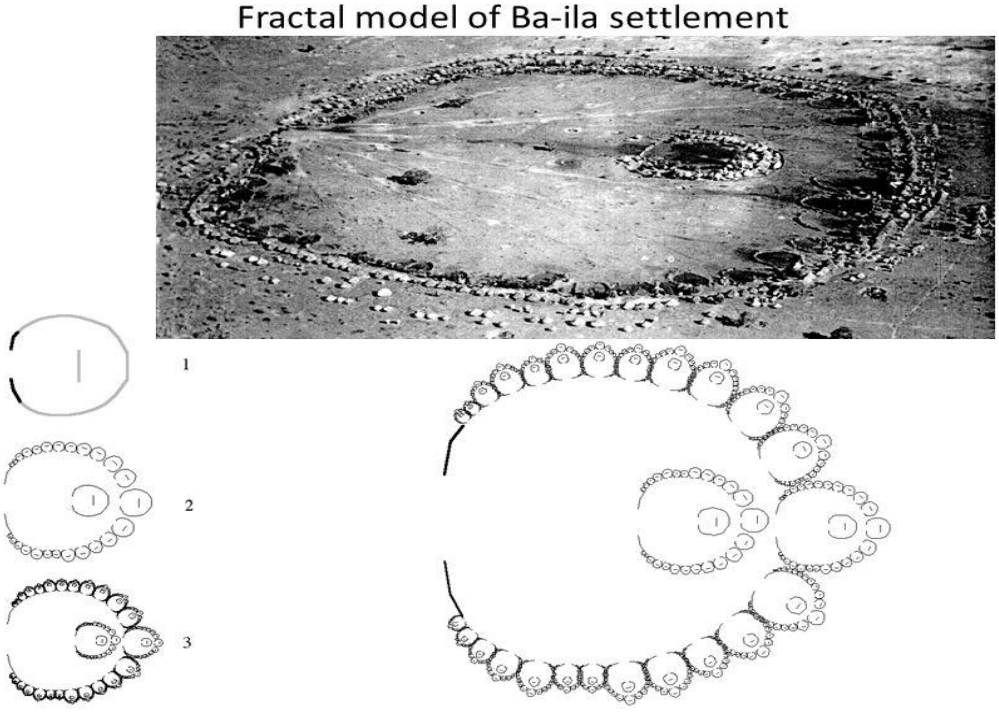


Figure 2. 10: Ba-ila settlements in South Zambia (Eglash, 1999).

Nankani fractal settlements

Eglash (1999) observed that the Nankani's home in Ghana are fractal series of cylinders during his research on African fractals. One only sees one compound here, a cylinder of cylinders that shrinks in size as you revolve counter-clockwise around the central courtyard. One's existence in this community is dictated by the architecture. From the womb to the delivery room is the first rite of passage. The second option is to enter the courtyard via crawling. The third is from the courtyard to the entire village, and then from the village to the rest of the world.

The recursion to smaller scales is continued by scaling stacks of pots and bowls as shown in figure 2.11. The smallest bowl is the "*kumpio*," a shrine for the female head of the family, and the stack of bowls is called a "*zalanga*." The *zalanga* is broken when she dies, and her soul is liberated into eternity. While the architecture scales life from birth to death, the zalanga scales life backwards—from the largest bowls' rings to the tiniest bowls holding the soul, from the mature adult to the spiritual realm of ancestors who reside in the "earth's womb." The Nankani's scaling circle has a deliberate design: a recursion that bottoms out at infinity, signifying the passage of life and death. The total length of the building complex, including similar compounds, is around 20 meters;

the *kumpio* is around 0.2 meters (ibid, 1999). As stated before, Ghana's Copyright Act of 2005 protects cultural expressions and heritage (cf. page 23 & 24)) and the Nankani fractal settlements are protected by the same Act.

Figure 2. 11: Nankani fractal settlements (Eglash, 1999).

Mofou **fractal structures**

Mofou is a term used to describe numerous ethnic groups and languages spoken in northern Cameroon, near the Nigerian border. Ostwald and Vaughan (2016) explained that the structures of Mokoulek, a Mofou community in Cameroon's *Mandara* Mountains, are constructed by stacking stones that cover the area where they live. Small circle constructions and other huge circular constructions spiral within three enormous stone enclosures that spiral from a central point, displaying fractal self-similarity in its creation. Natural fracture lines run through much of the stone, which tend to divide into broad flat sheets. These ready-made bricks, combined with the necessity for protection, are aided in the construction of their massive castle-like constructions. Small circular granaries and bigger circular granaries spiral within three enormous stone enclosures, which spiral from a central point, rather than the Euclidean shapes of European castles (Baier & Bicudo, 2020).

The way the system expands to accommodate growth is determined by a recipe or algorithm, Eglash (1999) highlighted. Knowledge of the agricultural yield determines

it. This volume was then divided into a number of granaries, which were then spiralled together. The design is not just a question of slapping granaries on top of each other at random; it's the result of a quantitative and planned procedure. The square structure is the village altar. It is the site of religious and political power, as well as agricultural fertility and ancestral succession cycles rites. The architecture's self-generating geometric algorithm mirrors a self-generating societal paradigm once more as shown in figure 2.12. According to the Bamileke symmetrical masks discussion, Cameroon ratified the UNESCO Convention for the Protection of the World Cultural and Natural Heritage in 1982 (cf.page 25 & 26).

Mokoulek village plan

Photo of Mokoulek

Figure 2. 12: Mofou fractal settlements (Eglash, 1999).

Logone-Birni fractal settlements

An aerial shot of the chief's residence in Logone-Birni, Cameroon is shown in Figure 2.13. Read (2004) stated in African Fractals. The simulation seen below is a golden rectangle that can be subdivided indefinitely. The midway map of the way to the throne room resembles a golden spiral. The royal emblem (right) contains three rounds of scaling rectangles, indicating that they are fully aware of their architecture's scaling capabilities. Replacing outside lines with internal lines is one technique to replicate the

palace (Bennett, 2012). Another option is to proceed in the opposite manner, starting with a little seed in the middle and expanding outward.

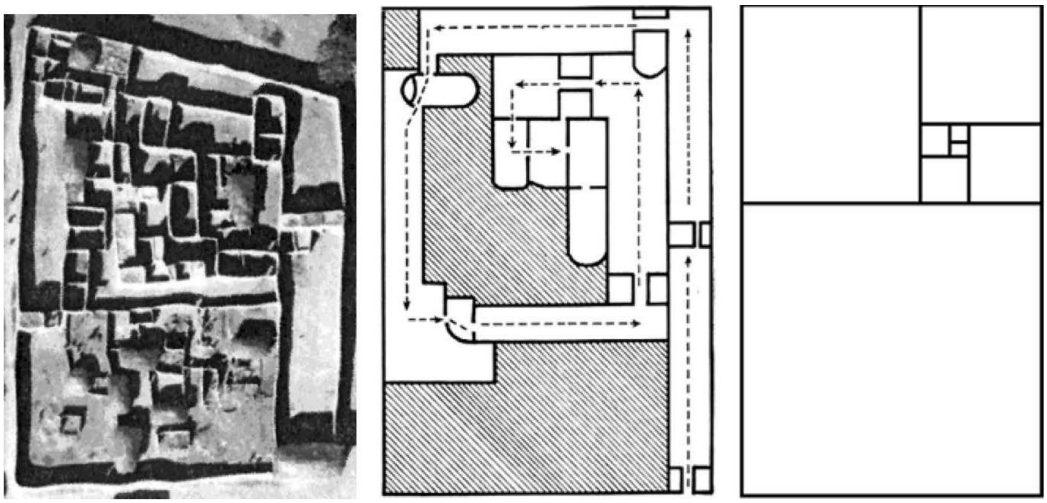


Figure 2. 13: Logone-Birni fractal settlements (Bennett, 2012).

Braided fractal hairstyles

Cornrow or braided hairstyles can be designed using the same building approach based on a fractal shape. For a long time, Africans have braided variations of the same form utilizing fractals to create gorgeous and elaborate hairstyles. Eglash (1999) recognized the use of fractal geometry. Women's hairstyles in Nigeria's Yoruba culture have a rich history and function (Ajbóyè, 2018). Female hair is let to develop naturally before being weaved and threaded into numerous coiffeurs with well-known names (James, 2021).

Threading is a relatively new technique compared to weaving. Both hairstyles are considered household knowledge among women, passed down from generation to generation (Lutzky, 2012). Cornrows have been worn by ladies since at least 3000 B.C. (see Figure 2.14) and by men since the nineteenth century, particularly in Ethiopia. Cornrows can symbolize one's age, religious views, kinship, marital status, and income, and were also a means of self-expression in West Africa, Sudan, and the Horn of Africa (Djibouti, Eritrea, Ethiopia, and Somalia). Shells, glass, corals, fresh flowers, and twigs were utilized by both men and women to beautify their cornrows and reflect their individuality.

Figure 2. 14: Fractal African cornrows (Eglash, 1999)

2.3.1.7 African geomancy and binary system

African geomancy is a divination approach that interprets ground markings or patterns created by tossed handfuls of soil, rocks, or sand. The most common method of divinatory geomancy entails reading a set of 16 figures created by a randomized process involving recursion and analysis, which is frequently supplemented by astrological readings. Geomancy is the science of predicting the future (tossing sand, rocks, or pebbles and interpreting the shapes that it makes). They, along with many other mathematicians, were able to create a composite binary system, which led to the development of most of today's technology. Computers now run on binary systems, and even the on/off switches on appliances are binary.

The Bamana divination

The Bamana divination, a form of geomancy, is thought to have existed in Senegal before the 9th century. It was brought to Spain in the 12th century, and this geomantic chart was shown to King Richard II in 1390. German mathematician Leibniz in his dissertation “De Combinatoria,” in which he presented binary code, also referenced it in the 1600s (Eglash, 2013). Eglash (1997) highlights the lengthy tradition of repeated looping in Bamana sand divination to construct sets of binaries in his research. Iterative looping is a term used in math and cybernetics to describe a reflexive process in which the outcomes of an operation are passed back as inputs. Binaries are generated in Bamana divination by coupling four sets of random dashes in the sand and noting odd and even results to construct a symbol. This procedure is carried out four times. Each of the generated symbols is paired to produce two more symbols.

Each symbol's meaning is assigned a position, or 'house,' in Bamana divination; the symbols and their placements in the divination are read in relation to one another [e.g., desire in the home of journey = want to travel].

Binaries are used to code self-generated variation in this procedure. In concept, it's akin to Marston Morse's nonlinear dynamics 'chaos' model for self-generated variation, (Eglash, 1999). Eglash (1997) described the Banama divination technique in more detail as follows:

The divination starts with four horizontal dashed lines that are created quickly with random differences in the number of dashes in each. The dashes are then joined in pairs, leaving one single dash (in the event of an odd number) or no dashes on each of the four lines (all pairs, the case of an even number). The narrative symbol is thus made up of four vertical lines, with double vertical lines signifying an even number of dashes and single vertical lines signifying an odd number of dashes (see figure 2.15).

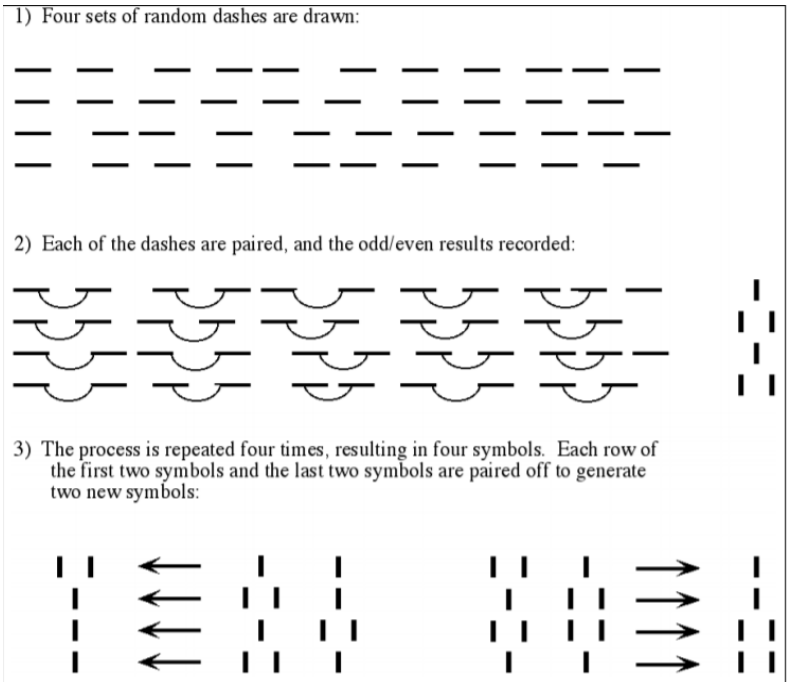


Figure 2. 15: Banama sand divination (Eglash, 1997)

The first four divination symbols are created in this way, but the next 12 are created through an iterative loop in which the operation's output is used as the input for the following stage (figure 2.16). The operation in this example is addition to modulo 2 ("mod 2" for short), which simply returns the remainder after division by two. The parity bit operation, which checks for mistakes on modern computer systems, uses the same

even/odd distinction (Ibid, 1997). The diviners reapply mod 2 to each row of the first two symbols, and each row of the last two symbols, rather than interpreting each position in the column as having some value (as would the Western binary number 1011, which represents one 1, one 2, zero 4s, and one 8).

After that, Eglash (1997) stated that results are combined into two new symbols, and then mod 2 is applied once more to create a third symbol. By reading the rows of the initial four symbols as columns, another four symbols are generated, and mod 2 is applied recursively to generate three more symbols. Mod 2 recursion is also used to generate the last two symbols, which are formed by combining the two bottom symbols to make a 15th and the last symbol with the first symbol to make a 16th (bringing the total depth of recursion to five iterations). As a result, a deterministic technique is utilized to iteratively produce 12 more symbols from a stochastically created "seed" of four symbols. A small stochastic variation is amplified into deterministic chaos, much as it is in weather prediction (Jansen, 2005). Senegal's Law No. 2008/09 on Copyright and Neighboring Rights, enacted on January 25, 2008, protects all Traditional Cultural Expressions within the state.

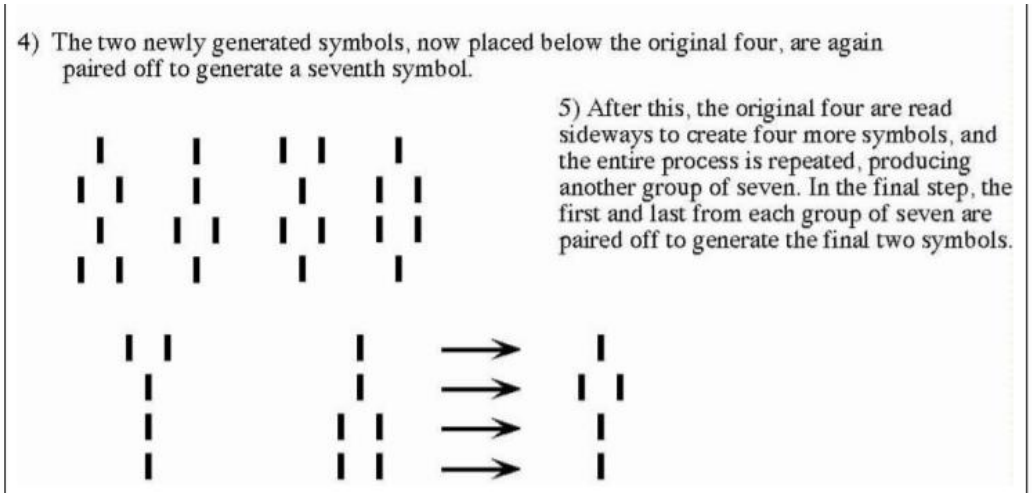


Figure 2. 16: Banama sand divination continued (Eglash, 1997)

The Ifa divination

The Yoruba gods of western Nigeria are thought to have once existed as humans with their own language. Ajala (2013) and Adegbindin (2014) described that they left a way for humans to contact with them in the outer realm before they vanished (the ifa divination). Africans established Ifa Oracle divination around 12,000 years ago, based on the square of 16=16x16=26 = 28 which corresponds to the vertices of an 8-

dimensional hypercube and the binary 2-choice. Ifa divination based on the binary system is spiritual, holistic, and based on the diviner, patient, and ancestors' agreement. In Ifa divination, the concept of YES and NO is applied (Oladimeji et al., 2019). The use of the binary system in computer science has been impacted by the definition.

Ifa also adopts a geomantic divination methodology to arrive at acceptable indications and interprets those using Ifa rhymes. The Ifa divination has a device known as an opele, which is a divining chain with two arms made up of eight dots on the left and right sides, like computers. Figure 2.17 depicts the Ifa literary corpus, which is divided into 16 primary odu (chapters) and 256 potential outcomes termed odu, with each odu including stories called ese (Pogoson & Akande, 2011). In computer science, a binary number constructed from the arrangement or combination of zeros and ones is comparable to an odu Ifa in Ifa divination. In this way, Computer Science can be traced back to Ifa (Alamu et al., 2013).

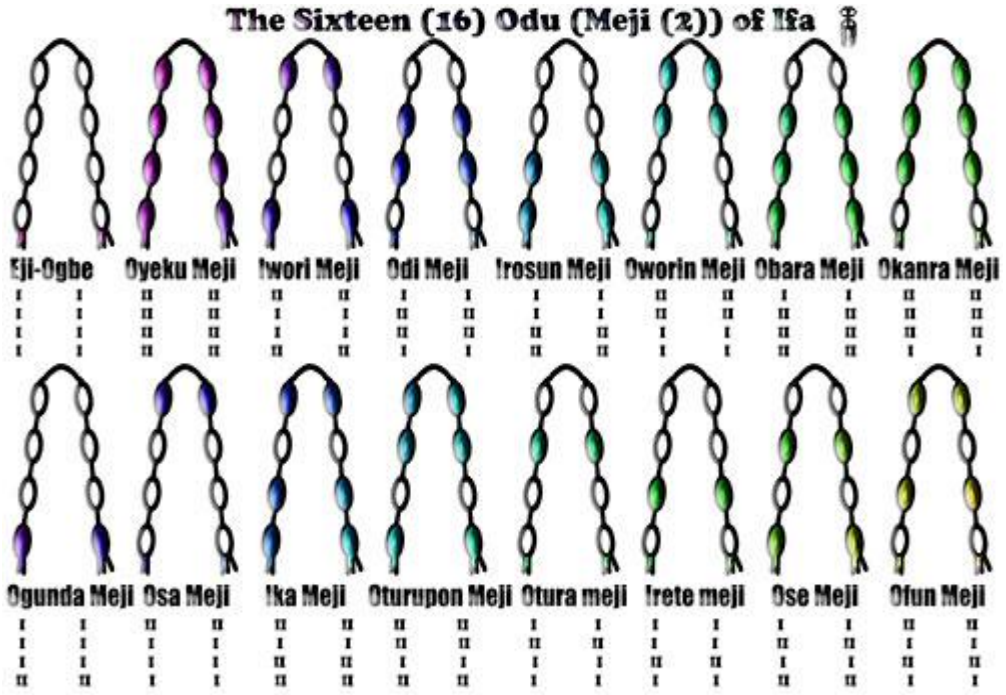


Figure 2. 17: Ifa divination system (Adams, 2019).

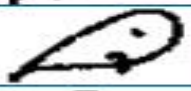
2.3.1.8 African numeral systems

Egyptian numeral systems

Miatello (2011) explained that the term “Egyptian mathematics” refers to mathematics written in Egyptian. “The Greek began to supplant Egyptian as the written language of

Egyptian intellectuals throughout the Hellenistic period" (Boyer & Merzbach, 2011: 8). Faruqi (2006) stated that Mathematical study in Egypt was later continued as part of Islamic mathematics in the Arab Empire, when Arabic became the written language of Egyptian scholars. The Egyptians are the most well-known of all ancient languages, texts, and mathematics. Hieroglyphic writing was used by the Egyptians. They did maths in hieroglyphics as well (Miura & Okamoto, 2013). As demonstrated in Table 2.1, hieroglyphics are markings and symbols used to represent words and numbers. The Egyptian numerals were written as follows:

Table 2. 1: Egyptian numerical language (Allen, 2000).

Decimal Number	Egyptian Symbol	What it is supposed to be
1 =		staff
10 =		heel bone
100 =		coil of rope
1000 =		lotus flower
10,000 =		pointing finger
100,000 =		tadpole
1,000,000 =		astonished man

Antiquities Protection Law No. 117 of 1983, as amended by Law No. 3 of 2010, Law No. 61 of 2010, and Law No. 91 of 2018, as well as the law's executive regulations, "is one of the most important Egyptian laws enacted with successive amendments to achieve the legal framework needed to protect Egyptian antiquities and heritage. It also acts as the first line of defence against antiquities theft, unlawful excavation, and smuggling" (ICCROM, 2020:1).

Nigerian numerical systems

Oyabade (2010) conducted a study on the documentation of African counting systems. Yoruba and Ekiromi share a lot of parallels in their core computing concepts, he

discovers. “The use of base five, decimal (base ten), vigesimal (base twenty), and the numeral 400 as basic elements are identical in the two languages,” says the author (Oyebade, 2010:17). Despite the numerical parallels between the two languages mentioned above, there are some number discrepancies between them.

South African numerical systems

The Basotho have made numerical reasoning an essential part of their vocabulary; no distinction between numerical and linguistic use exists in the Sesotho language. Different from the English language in which mathematical reasoning and language are separated, in the Sesotho language numerical and linguistic domains are strongly coupled (Zulu, 2012). “The Basotho mathematical knowledge is integrated into the language. This means the Sesotho language has native support for mathematical knowledge. The language provides a built-in facility for numerical reasoning. This is in contrast with the English language whereby mathematics and language are separate” (Ibid, 2012: 2).

The majority of the terms are related to counting with your fingers and toes. The first six number words demonstrate this (As shown in table 2.2). Moving from one hand's five fingers to the next finger (or thumb) of the other is referred to as "crossing over" and "taking the thumb." For the numbers 9 and 40, ‘one in the belly' alludes to the nine months of pregnancy, and ‘a mattress' alludes to the total number of fingers and toes of husband and wife laying together on a mat/mattress (Zaslavsky, 1973b: 532–535). It is also worth noting that the VhaVenda people of South Africa use two different counting systems (Table 2.3), one based on base ten and the other on base five (quintenary). Examples from the Basotho and Vhavenda counting systems are given below:

Table 2. 2: Basotho counting system (Zaslavsky, 1973b)

Basotho counting system

Number	**Word**	**Is derived from the phrase meaning…**
1	Nngwe	Alone/one
2	Pedi	Being two/two
3	Tharo	Being three/three

4	Nne	Being four/four
5	Hlano	Complete hand/five
6	Tshelela	Cross over
7	Supa	Point (pointing finger) seven
8	Robedi	Break two (from ten)
9	Robong	Break one (from ten)
10	Leshome	Richness (use two hands to carry)

Table 2. 3: VhaVenda counting system (Zaslavsky, 1973b)

Vhavenda counting system (base 10)

Number	Word	is derived from a phrase meaning ...
1	nthihi	alone/one
2	mbili	being two/two
3	raru	being three/three
4	ina	being four/four
5	thanu	complete hand/five
6	rathi	cross over/six
7	sumbe	pointing right finger/seven
8	malo	marry (number of cattle needed to marry)/eight
9	tahe	short (one is missing)/nine
10	fumi	rich/fullness (use two hands to carry)/ten

2.4 Attempts by early scholars on the same topic

This study incorporates several bodies of literature by early scholars who have made affair attempts researching about AmaNdebele. Works of scholars which was analyzed for this research date from 1921 when the first thesis about AmaNdebele was conducted to present literature. The aim of analyzing old studies was to capture early literature on the origin of AmaNdebele culture and current studies. Such approaches are necessary for this type of study because culture is not static but dynamic, that is to say, it adapts from time to time, to changes and new developments. From a historical, cultural, and artistic perspective, the following analyzes and excerpts from articles and studies represent the major body of literature on the AmaNdebele.

2.4.1 Previous studies on AmaNdebele artefacts

A doctoral thesis by a student of Dutch Reformed Theology, H.C.M. Fourie, is the earliest known, and documented a report on the AmaNdebele. His book was published in 1921 under the title AmaNdebele van Fene Mahlaneu en hun Religieus-Sociaal Leven. This book is not readily available and is unavailable to scholars without a knowledge of Dutch working. However, Kuper (1978), Professor of African Cultural Anthropology at Rijksuniversiteit, Leiden, published an English-language article entitled "Fourie and the Southern Transvaal Ndebele," summarizing the content of Fourie's work.

Kuper (1978) agreed that Fourie (1921) has presented detailed explanations of certain ceremonies, such as the wedding rituals, but he refers in passing to the bride's appearance, not discussing the sophistication of geometric shapes in her attire and those of other women who support her during the ritual ceremony. Other very general references to adornment are cited in connection with the *wela,* associated with male initiation and rituals.

Fourie's apparent lack of knowledge of Ndebele's material culture is almost certain because it seems that no fieldwork had been performed, but he relied on the texts he got from informants who may not have been Ndebele. Fourie possibly observed a few ceremonies first-hand, as claimed by Kuper (1978), however, most of his accounts were based on information from others.

Matthews' (1971) article titled "*Painting in South Africa*" identifies mural painting in South Africa as a domestic art. This resource points out that it is the women within the South African groups who create the murals it discusses the techniques that are used to create the murals. However, the discussion is limited to the production of traditional mural art rather than how the murals are applied and arranged.

Levy (1990) completed a Masters dissertation entitled "Continuities and Changes in Ndebele Beadworks, c. 1883 to the Present." Her research is inspired by AmaNdebele written reviews, with drawings by Fourie (1921), Kuper (1978), Weiss (1963), van Warmelo (1930), and Meiring, among others. In chapter two, Levy clarifies the origin of AmaNdebele artefacts and contends that the dating of this art is exceedingly tricky, there's proof to propose that it was as of now being delivered amid the late nineteenth century, and not prior. The most punctual extent things can be dated to at least the

late 1800s, and the earliest known photographic documentation of the Ndebele, outlining the utilization of beadwork, dates to the 1920s and 1930s. The photographer Alfred Martin Duggan-Cronin took many of these pictures: his work was discussed on chapter one Levy's study. Therefore, based on the reviews of Levy (1990) this study hopes to discover the origin of AmaNdebele artefacts and fill in the gap many researchers have attempted to close.

Levy (1990) further elaborated that it is possible that the various styles of beading have been related to certain ceremonies from their inception, which served to emphasize gender, identity, age, and marital status. Despite the fact that commercial needs have led to the sale of beaded goods to collectors" and tourists, especially since the 1970s, beadwork continues to serve these functions. From the 1950s to the present, the social purpose of beading is a constant thread in the information gathered by all studies. These functions are still described by Ndebele women, as passed down from their mothers and grandmothers. Levy (1990) argued that Ndebele beadwork is no longer worn nor "manufactured as regularly as it once was", which is an incorrect statement. Currently, Ndebele women have developed new styles and designs of Ndebele beadwork to attract local and international tourists. The original cultural beads are still worn, especially during events that symbolise cultural identity which is a topic this study will further elaborate on. Therefore, Ndebele people continue to see the significance of their artefacts in general, and the practice by women has greatly increased compared to the past years. This has been done for commercial reseaons, cultural expression and identity.

Powell's (1995) *Ndebele: A People and Their Art* is a major contribution to understanding the AmaNdebele and their distinctive culture. Specifically, this study gives an overview of the history, beliefs and practices, mural art, homesteads, beads and adornments and the contemporary trends of AmaNdebele but it does not provide a detailed focus on the origin of Ndebele artefacts and how artefacts are applied by AmaNdebele women, which are aspects this study will investigate and address.

Van Vurren (2012) who is an Anthropologist and Archaeologist, wrote an article entitled "Iconic bodies: Ndebele women in ritual context". In this article, he wrote on the Ndebele culture, focusing mainly on the spirituality/rituals in the Ndebele attire, beadwork, and brass rings. Van Vurren (2012) has fully expressed the role of women

in rituals, the expression of the identity of the AmaNdebele through rituals yet there are errors in his study, which are terms that do not exist in the Ndebele language. Throughout Van Vurren's (2012) article, many errors were identified in AmaNdebele beaded attires. This, which shows that he did not have a Ndebele-speaking interpreter for his research These errors dishonour the Ndebele culture and show the scholar's contempt for the entire Ndebele language.

It cannot be ignored that language barrier has become a serious hurdle for most researchers because the AmaNdebele themselves had not transcribed much of their results. It should be mentioned that non-IsiNdebele speakers have no language error issues but this can be a serious issue for Ndebele speakers. It is those gaps that the researcher hopes to overcome and correct as a Ndebele.

Van Warmelo (1930) who conducted research on AmaNdebele history used Fourie's (1905) findings in Native Affairs Department publication called *"*History of the Native Tribes of the Transvaal*",* as well as data gathered from informants during his own fieldwork. Van Warmelo admitted that writing about the AmaNdebele was difficult due to a lack of understanding of their history (1930). However, his assertion that knowledge based on "tribal tradition" was unreliable "because individuals who truly know their people's past are few" (1930:8) is highly debatable, given that oral history is progressively regarded as a credible and valuable source of knowledge. It gives an account of events from the perspective of the people who lived through them, and thus may be a more accurate representation and understanding of events than other written histories.

As Hamilton (1985) claims in Ideology, her M.A. dissertation,"Oral Tradition and the Early Zulu Kingdom's Power Struggle, oral traditions" provides a wealth of information about their roots and origin. Therefore, the AmaNdebele are capable of tracing down their origin through information that has been shared from one generation to another. Despite his prejudice, Van warmelo documented important aspects of myths about the AmaNdebele's origins, along with some versions that were quoted in detail, both in the dialect and in translation.

Between 1931 and 1955, Meiring (1931), who was a Professor and the head of Pretoria University's School of Architecture at the time, was one of the first scholars to write about AmaNdebele culture. "Lets oor die Amandebele" (1931), "Kultuur van die

Bantoe" (1949), "So bou die N'debele hul hutte" (1953), and "The Amandebele of Pretoria" (1954) were among his articles (1955). Meiring's emphasis in both of these papers was primarily on architecture and wall decoration. His curiosity grew to the point where, in 1953, he enlisted the help of Pretoria University's School of Architecture to document a specific Ndebele settlement that was being forced to relocate (1953:224; 1955:28).

In his writing Meiring (1955) however, does not indicate the purpose AmaNdebele were forcefully removed from their settlements. A published newspaper article of 1953 indicated that ”120 inhabitants of the village (had) ... been given notice by their European landlord", and they were "taken in lorries to Klipgat in the Native Reserve, 25 miles from Pretoria" (E.P.A. 1/9/53). As a result, Meiring's top priority was to conserve a piece of AmaNdebele material culture that was visible among the people of "this lovely settlement" (1955:27), who took such "painstaking care in the execution of the bold patterns of coloured decorations on the walls" (1955:28). Such information for this study is critical and further information on culture preservation after the migration is provided in chapter 7.

Meiring made comments on the 1883 Mabhoko war (miswritten as Mapoch war) between Boers and the AmaNdebele and stated that the AmaNdebele were defeated by white farmers. However, he does not elaborate on the suffering the war brought to the AmaNdebele and how that affected the cultural expression of the AmaNdebele. Instead, he presents a picture which shows people not affected by the changes to their lives and who "just picked up the threads as they had left them in their country of origin and, transplanted all the old traditions and customs to their new life on the farms" (1955:27). Meiring's simplistic interpretation of historical events not only shows a lack of empathy and awareness into pain and possible perceptions of the AmaNdebele themselves, but it also does a disservice to the work. The fact that the AmaNdebele lost all of their land to the Boers after the Mapoch War of 1883; that their location on white farms during the 1940s and 1950s was a historical consequence of this war, as was the fact that they had no control over, or choice as to where they could live, and that their eviction left them with nowhere to go, were not taken into account.

Instead, the group was interrupted by apartheid legislation again a generation later, according to the settlement's subsequent history. For many years, this town served as

the KwaMsiza tourist village. It became a destination for foreigners, i.e. tourists, who came to see the AmaNdebele in their "natural" habitat and purchase their "traditional" wares. This portion of land was merged into Bophutatswana's 'independent homeland' in the 1970s, making it unsuitable for AmaNdebele to live there. This village 'disappeared' essentially. Despite the fact that it is no longer used as a tourist destination, some AmaNdebele families continue to reside there. The study will go into greater detail about the use of KwaMsiza village as a tourist attraction in Chapter 7.

Much of the literature on the artefacts has tended to focus on a typology of the art to the exclusion of its history and changing roles, with authors focusing on a typology of the art to the exclusion of its history and shifting functions. This strategy can be seen in previous and subsequent articles. Therefore, this study will shift its focus to the origin of the AmaNdebele history and provide an in-depth focus on the cultural functions of the AmaNdebele artefacts.

2.4.2 Previous studies on the protection of AmaNdebele mathematical artefacts

In that, they symbolize a country's cultural heritage; intellectual properties serve as a vital foundation for African material culture. They are priceless artefacts that encapsulate Africa's past and present energy and ingenuity and can reflect the continent's future if properly preserved. According to Prott (1996), illicit trade has a significant impact on current community life, not only in terms of economic loss due to the loss of items that could have provided economic benefits but also in terms of the loss of the best example of a cultural tradition to inspire younger artists, resulting in the deterioration of artistic skills and disparagement of local culture. As per Prott (1996), illicit cultural property trafficking is a global phenomenon that affects practically, every civilization. Significant cultural objects remain in traditional communities in many African countries, but they lack the protection of even basic security systems or strong belief systems that would have previously made it impossible for a member of the community to cooperate in the removal of an important cultural object.

Josey (2004) who conducted a study on AmaNdebele intellectual property entitled “The Ndebele of South Africa and Their Intellectual Property Rights” stated that with the formation of a new administration, South Africa has the chance to act as a catalyst for economic growth while also assisting in the construction of a credible long-term

development plan for the AmaNdebele. South Africa already has an intellectual property regime in place as well as a thriving private R&D investment sector. According to Josey (2004), The Paris Convention on Patents, Trademarks, and Designs, as well as the Berne Convention on Copyright, are both signed by South Africa. This Directorate is in charge of eight acts, the most important of which are patents, trademarks, designs, and copyright. AmaNdebele artists could have complete control over the creative items they generate by establishing and enforcing legal laws, educational programs, and well-designed and developed marketing strategies, proposals, and initiatives. These initiatives, projects, and programs must have the backing of the South African government, government officials, the private sector, and the general public in order to succeed (Ibid, 2004).

The Indigenous Knowledge Systems (IKS) Policy, which was adopted in November 2004, was the outcome of a multi-departmental effort to develop a framework for the acknowledgement, understanding, integration, and promotion of South Africa's vast indigenous knowledge resources. The strategy identifies several areas of action, including the protection of indigenous knowledge and the people who retain it from exploitation. This would also entail ensuring that communities receive a fair and consistent acknowledgement, as well as, where appropriate, financial compensation, for their knowledge (Mosimege, 2004).

According to the South African Intellectual Property Policy Act (IPP) of 2018, the Department of Environmental Affairs (DEA) promulgated and administers the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA or Biodiversity Act) and the Bioprospecting, Access and Benefit Sharing (BABS) Amendment Regulations. The Act's objectives do not address Indigenous Knowledge Systems as a whole, but rather a single facet, biodiversity. This can be observed in the following statement:

> “The objectives of the Act include, among other measures, conservation of South Africa’s biodiversity within the framework of the National Environmental Management Act, 1998; the protection of species and ecosystems that warrant National protection; the sustainable use of indigenous biological resources; and the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources”.38

Bagley (2018) wrote a paper entitled *Toward an Effective Indigenous Knowledge Protection Regime Case Study of South Africa.* The work focuses on the South African Indigenous knowledge protection regime, which has four main features: bioprospecting regulation and economic development; an innovative Indigenous knowledge documentation system for defensive protection; positive protection through an as-yet unimplemented sui generis initiative; and links with the intellectual property (IP) system. Successful benefit-sharing arrangements are few, but they appear to be on the rise, thanks in part to organizations like the Council for Scientific and Industrial Research (CSIR), which have been assisting interested Indigenous knowledge-holder communities in turning their knowledge into engines of economic development.

Concluding remarks

This chapter has provided literature on the origin of mathematics in different African cultures and how it is utilized. It has stated that African nations use mathematical knowledge as part of their cultures, proving long existing history of mathematics. The study further looked at existing literature on AmaNdebele culture. Studies reviewed did not provide details on AmaNdebele mathematics. Rather, they focused greatly on the history of AmaNdebele, the cultural significance of AmaNdebele artefacts and the *Mabhoko* war. Some studies were acknowledged for the in-depth knowledge provided about AmaNdebele and their culture while provided the researcher with existing gaps, which will be addressed by this study. The next chapter presents the African philosophical underpinnings of the study.

CHAPTER 3: AFRICAN PHILOSOPHICAL UNDERPINNINGS OF THE STUDY

3.1 Introduction

The previous chapter focused on the origin of mathematics in Africa. It mainly looked at Africa's origin of mathematics and the role of mathematics in different cultures. It further looked at the early writings on AmaNdebele artefacts and identified gaps which will be addressed by this study. In this chapter, the philosophical underpinnings of this study are presented. The research argues that foreign and interdisciplinary academics have written about indigenous perspectives and worldviews since mid 1990. Their lense was based on colonization and racism which indigenous scholars' ave worked hard over the years to decolonize (Harvey, 2003; Thaman, 2003; Absolon & Willett, 2004; Howitt & Stevens, 2005; Shaw et al., 2006). Indigenous people have been cut off from their traditional beliefs, spirituality, property, families, community, spiritual leaders, medicine people, and the list goes on because of the legacy of invalidating Indigenous knowledge (Absolon & Willett, 2004).

There is an urgent need to close the 400 years gap of marginalizing African people's indigenous knowledge systems. Such can be achieved by resisting the utilization of Western worldviews and methods while conducting research with indigenous people about their knowledge. The process of criticizing Eurocentric dominance in research which began in the 20th century has to continue and that will assist in articulating and reclaiming their peoples' research methodology and paradigms (e.g., Battiste, 2000; Dei, 2000; Graveline, 2000; Rigney, 1999; Smith, 2012). Furthermore, these indigenous scholars strive to actively combat colonial and postcolonial incursions by re-establishing the experiences and ways of knowing that have been repressed by dominant western knowledge communities (Whap, 2001).

Indigenous peoples must guard against further misrepresentation, misinterpretation, fragmentation, mystification, commodification, and simplification of Indigenous knowledge (Deloria, 1995; Sue and Sue, 1990; Fixico, 2013). False representations foster a false awareness that prevents Indigenous people from learning as much as they can about themselves and perceiving themselves as they truly are. These photographs establish 'manufactured contexts,' further separating them from their natural surroundings.

Indigenous worldviews, Ubuntu philosophy, indigenous research methodologies, and indigenous research paradigms, among other decolonizing research methodologies, are critical in the development of new ways to reclaim control over our Indigenous ways of knowing and to reinstate lost ancestral teachings, values, and goals (Laenui, 2000). To transform change for and by indigenous people, a “long-term process involving the bureaucratic, cultural, linguistic, and psychological divesting of colonial power” (Smith, 1999: 98) is required, in which First Nations people have the right to self-determination through principles of "ownership, control, access, and possession of research” (Schnarch, 2004: 94).

In order to undertake authentic indigenous research, Smith (1999) suggests that there must be a good relationship between indigenous scholars, researchers, and community members. It is vital for all parties engaged to improve their understanding of indigenous knowledge and theories. Indigenous research serves as a tool for survival, healing, and self-determination by “filling a need to know and extending the bounds of current knowledge through a methodical inquiry process” (Smith, 1999: 170). As a result, Indigenous population must create, implement, and assess solutions to complicated situations in their communities (Gone, 2019).

Understanding the importance of Indigenous knowledge and the ways in which Indigenous people make sense of life in today's world is critical to Indigenous study. Indigenous knowledge is based on spirituality and covers cultures, histories, and geographical areas that are beyond the physical world (Dei, Hall, & Rosenberg, 2000). This insight and intuition about the interconnectedness of life, the earth, and the cosmos is part of this wisdom. Indigenous knowledge emphasizes relationships between the person and these entities, as well as multiple ways of knowing (verbal and nonverbal), language and place, values, holistic nature, and metaphysical teachings from dreams, visions, and ceremonies (Dei et al., 2000; Kovach, 2009).

This chapter establishes the study's philosophical underpinnings by bringing together discussions from different scholars who have done and had viewpoints on indigenous research. The use of an indigenous lens when conducting indigenous research and understanding indigenous methodologies appropriate for indigenous research are discussed in this section of the study. Using proper methodologies for indigenous research contributes to indigenous research's indigenization and decolonization. This

chapter begins with defining and explaining African indigenous knowledge as a foundation for research with indigenous peoples, as well as discussing the need of decolonizing and indigenizing research.

3.1.1 African indigenous knowledge

Indigenous knowledge or African indigenous knowledge, as the terms are used interchangeably in this study, and can be defined as “experiential knowledge based on a relational worldview and culture. Wholeness, community, and harmony are profoundly rooted in cultural values in the spirit of the African worldview. Only in the presence of others does a person become human, and the essential duty in the process of becoming a true person is to seek both individual and societal harmony” (Sarpong, 2002: 18; 2019). Like its people, knowledge is acquired jointly and communally. The African worldview is characterized by a strong commitment to communal ideals and peace, which is based on a collective sense of duty that recognizes that group survival is dependent on interdependence and connectivity (Mkabela, 2005; Sarpong, 2002).

Knowledge cannot be seen as fixed categories, experiences, or social behaviours, according to Dei et al (2002). Wane (2002; 2005) emphasizes the dynamic nature of indigenous knowledge by pointing out that indigenous forms of knowledge have accumulated over time, which is an important component of cultures. Wane (2005) claims that knowing old information leads to the discovery of new knowledge, which is what makes indigenous knowledge more dynamic. When studying African indigenous knowledge forms, it is necessary to recognize the intricacies of their evolution as a result of their transition, enrichment, and devaluation throughout colonialism (Matsika, 2012).

Furthermore, because Africans are more knowledgeable about their own IK than outsiders, they must be in charge of IK analysis, testing, application, and investment. According to Mawere (2010), academics interested in IK studies should be aware of multiple knowledge systems. As a result, IK research must be wide, incorporating not only a positivist but also a pluralistic approach that includes grounded theories and interpretivism. According to Mawere (2010), the larger ambiguity is in the minds of scholars rather than in indigenous communities with their knowledge guardians (ibid, 2010).

Aikenhead and Ogawa (2007) stated that Indigenous ways of knowledge generation are built on realities that are contextualized regionally, environmentally, and seasonally. Adults impart practical knowledge of culture, the environment, and survival through demonstrations and a vast range of ceremonies, stories, songs, village meetings, and taboos, which are passed down from generation to generation through traditional education. In contrast to the aspirations of some Western scientific traditions for universal truths, indigenous epistemologies are narratively rooted in natural communities defined by complex familial networks of links among people, animals, the land, the cosmos, and so on (Mkabela, 2005).

Nevertheless, oral tradition, which is distinctive of indigenous knowledge systems, is frequently dismissed in favor of written tradition, despite the fact that this is incorrect. Many people have misunderstood indigenous knowledge for simplistic and not susceptible to systematic scientific research, partly because it is primarily oral and not written, and partly because it is people-centered and not always easily'measurable' (Emeagwali, 2003; Emeagwali & Dei, 2014). Community rites and rituals, such as story-telling, proverbs, folktales, recitation, demonstration, sport, epic, poetry, logic, riddles, praise, songs, word games, puzzles, tongue-twisters, dance, music, and other education-centered activities, reveal the rich complexity of the culture (Ngara, 2007; Moahi, 2012).

3.1.2 African indigenous Knowledge in research

The realization of African indigenous knowledge's (AIK) neglected and endangered state typically drives research into it. Research projects aimed at redress and arguing for the inclusion of multiple worldviews and traditional wisdom still pursue a western scientific perspective, using established forms to write knowledge, with the academic stance as the center and the author as the knowledge holder - lauded by name but depersonalized as a human being (Keane et al, 2016).

Smith (1999) argued that there is a pressing need in Africa for relevant research that embraces indigenous knowledge. Smith (1999) goes on to say that indigenous research based on suitable methodologies is the only way to address all of the misinterpretations and errors that have previously undermined indigenous people and their knowledge. Indigenous research uses methodologies that are influenced by, resonate with, and are driven and supported by Indigenous peoples to respect and

honor Indigenous ways of knowing, being, and doing (Mpofu, 2002; Emeagwali & Dei, 2014)

Indigenous societies have shared ways of understanding that are influenced by how they view the environment, themselves, and their relationships, according to indigenous research (Dei, 2002; Moahi, 2012). As a response, indigenous knowledge comprises a wide range of reflections on and resistance to colonialism across a broad range of fields. Who owns the research process and products, as well as who generates, analyzes, reports on, and profits from them is a concern for indigenous researchers (Smith, 2012). The research strategy then moves to revise history. The idea that analysis is essentially value-driven is further highlighted by indigenous research, with researcher, participant, sociopolitical, and environmental values all influencing research appraisal (Kovach, 2009). As a result, it should be a spiritual as well as a political activity, as well as a vehicle for people to gather together to contribute to a community's well-being (Bishop, 1999; 2005).

At the heart of indigenous research is an emphasis on ethics and intersubjectivity in terms of information access and privilege, methodological tool collection, and presentation of opinions with physical, psychological, and socio-political repercussions. Indigenous peoples' self-determination is a top priority in both the research process and their daily lives, with indigenous consciousness security as a major component of indigenous methodology (Porsanger, 2004). Healing, mobilization, change, and decolonization are all on an indigenous research agenda (Smith, 2012).

Indigenous research also underlines the fact that research is inherently value-driven, with a convergence of researcher, participant, sociopolitical, and environmental values influencing the study process and outcome (Kovach, 2009). In a sense, it should be a process of people coming together to contribute to a community's well-being, as well as a moral and political activity. There are four axiological assumptions incorporated within indigenous research that are sometimes referred to as "the four R's": responsibility, respect, reciprocity, and, taken together as one assumption, rights and regulations, as depicted in Figure 3. 1. Researchers must be accountable to participants, communities, study topics, and design; they must also be accountable for the impact of their research on individuals and communities.

Research accountability, according to Lavalle'e (2009), goes beyond formal research durations, with researchers expected to be available to communities as needed in the future. Respect is demonstrated by engaging in methodological activities that publish findings and share knowledge; these behaviours can help researchers and their subjects form better bonds. Smith (2012) used the Maori term whanaungatanga, which means "relationships," to describe how everyone involved in research becomes family. When it comes to research, reciprocity refers to a shared power exchange in which researchers contribute to relationships and participants exercise self-determination. Finally, rights and rules provide that indigenous peoples have the right to self-determination and involvement, as well as that researchers must get free, prior, and informed consent from samples and communities.

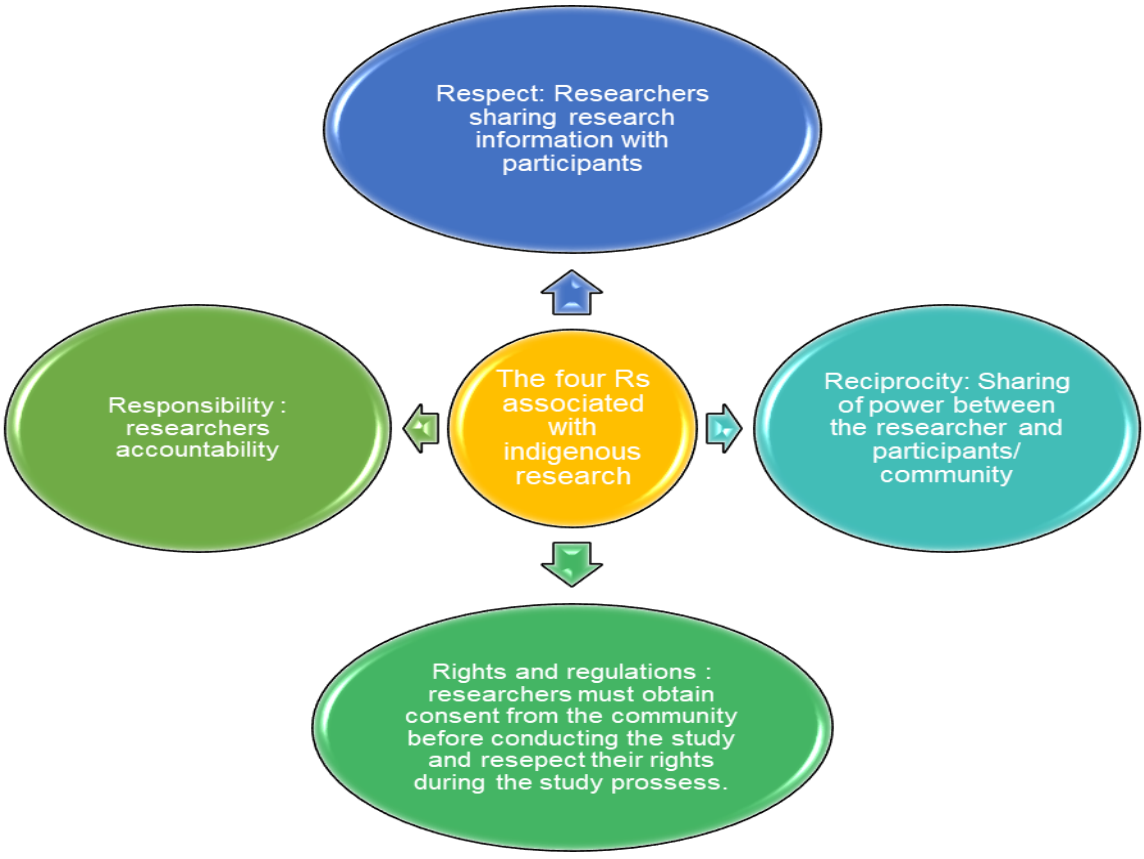


Figure 3. 1: The four Rs of Indigenous research (Bhuda & Koitsiwe, 2022).

Indigenous research enables indigenous languages to be recognized as an integral part of research studies. It is indeed critical that the value of indigenous languages must be recognized by researchers working in indigenous communities. As discussed in the following section, languages convey worldviews and ways of being tied to history and place. It is vital to create a space in their language for language speakers to

discuss the topics they are studying. This suggests that native speakers of the language understand the research topic and can share their expertise (Wilson, 2008). Language is crucial to indigenous peoples' life because it connects their past, identity, faith, and territory while maintaining culturally distinct ways of seeing and connecting to the world. Academics who want to learn from indigenous peoples must first acknowledge that the language incorporates ways of being and knowing, (Dana-Sacco, 2010). Language is the primary means of conveying worldviews. Concepts or words will frequently be addressed in the native language before an English response is given. When translating from an indigenous language to English, it might be challenging to grasp concepts (Mcarthy, 2003; Walsh, 2005).

Translation involves several complications since ideas are lost in translation. The necessity of internalizing the language, rather than pushing it to fit into English patterns of thought, was underlined by Jacklin et al (2020). Translations, as argued by Archibald (2008), lose a lot of the original language. Before they can explain a term in English, language users may converse. Kovach (2015) clarifies the extent to which meaning is lost in translation. Those who are not native language speakers comprehend the difficulty of creating information in a language that is not one's own, (Kovach, 2015; 2017).

The problems and misconceptions that come with learning a new language have been recognised on a global basis (Alderson, 2019). The relevance of Indigenous languages must be recognized by researchers working in Indigenous communities. Languages express worldviews and ways of being that are founded in location and history. It is critical to have a forum where language speakers can discuss research topics in their own tongue. This suggests that the speakers of the language are familiar with the research issue and have the opportunity to share their knowledge (Simpson & Wigglesworth, 2019).

3.1.3 The importance of decolonizing and indigenizing research

This study has in length discussed the importance of indigenous research and why indigenous communities have to be at the centre of the research study in order to correct the past representations by colonialists and non-indigenous scholars. In order to underline the methodologies and philosophies that are suitable to explore throughout a research process that focuses on African Indigenous knowledge and indigenous communities, it was vital to discuss the relevance of decolonization as a

core part of indigenous research for this study. To decolonize and indigenize research, indigenous ways of knowing must be taught, used in research, and valued on an equal footing with Western approaches to knowing and creating knowledge (Battiste, 2013; Khomba & Kangaude-Ulaya, 2013).

Decolonization is characterized as deconstructing the Western sciences' hegemonic base, which has historically oppressed Indigenous peoples, and reconstructing it so that Indigenous peoples are empowered in the operations and processes of research. Indigenous decolonizing approaches are, in essence, emancipatory and liberating in character for Indigenous scholars. Decolonization is a strategy for dismantling colonial theories of Western thought and practices, as well as their hegemony and privilege. It entails dismantling structures that keep the status quo in place and correcting power disparities. Decolonization entails returning Indigenous knowledge and practices to their previous position, as well as removing colonial prejudices and preconceptions that have shaped Indigenous ways of life (Smith, 2016). In the decolonization process, Chilisa (2012) highlighted five stages: rediscovery and recovery, sorrow, dreaming, dedication, and action. Rediscovery and recovery refer to the process through which colonial peoples reclaim and restore their own heritage, culture, language, and identity. According to Smith (1999), decolonizing entails deconstruction and restoration, independence and social justice, ethics, language, globalization of indigenous experiences, history, and criticism.

Decolonizing western research methods and approaches to integrate Indigenous means of obtaining, evaluating, and distributing new information is a goal of researchers working with and learning from Indigenous peoples (Donald, 2012). In order to apply an Indigenist research paradigm to the health services sector, non-Indigenous researchers must first evaluate their own worldview(s) in order to recognize that their worldview differs from that of the Indigenous peoples with whom they are collaborating. Indigenous research is distinguished by relational methodologies and the integration of Indigenous modes of communication such as storytelling (Bessarab & Ng'andu, 2010).

As shown in Figure 3.2, decolonizing research entails that research must be centred in indigenous people’s voices, research must be guided by indigenous worldviews, researchers must respect and honour indigenous people’s customary laws,

researchers must form good ongoing relationships with indigenous communities and indigenous research methods must guide the study (Tuck & Yang, 2012; Fataar, 2018).

Figure 3. 2: Components of decolonizing research. (Source, Researcher)

Indigenization is a collaborative process of naturalizing Indigenous intent, interactions, and processes and making them visible to transform environments, places, and hearts (Fataar, 2018). This includes including Indigenous viewpoints and practices in post-secondary education. 'Indigenization' necessitates cultural and contextual awareness. (Gray et al., 2008). In post-secondary education, this includes embracing indigenous perspectives and techniques. Indigenization necessitates not only adequate programs and infrastructure but also a significant shift in the way institutions operate:

- On a daily basis, including Indigenous worldviews, beliefs, and cultural understandings into policies and activities.
- Prioritize Institutions will incorporate indigenous ways of knowledge, which will then inform all actions.
- Integrate cultural protocols and practices into the functioning of the institution.

As a result of a growing understanding of the limitations of western research, teaching, and practice models, indigenization calls arose — and continue to arise (Gray et al.,

2008). According to the research, it has spurred a growing awareness of the great potential that exists in local rituals and behaviors that are impacted by indigenous traditions (Adair, 1999). It advocates for Indigenous research that is born out of, accurately depicts, and reflects back on the cultural environment in which challenges originate. As a result, Indigenous knowledge generation is reflexive, requiring researchers to incorporate their observations on local cultures, society, and history into their work. As a result, when indigenization is viewed as a way to better include Indigenous people in the academy, it is assumed that the academy is a natural, or at the very least neutral, space where human knowledge is already sufficiently represented (Battiste et al., 2002).

Figure 3.3 below shows that Indigenization includes the decolonization process, which entails challenging the authority of Western ideology and putting Indigenous knowledge front and center. Because it requires building new relationships between Indigenous and non-Indigenous peoples, Indigenization is a component of reconciliation. There are, however, important distinctions between these processes. Most crucially, decolonization is largely a settler responsibility, and Indigenous peoples must take the lead (Fataar, 2018).

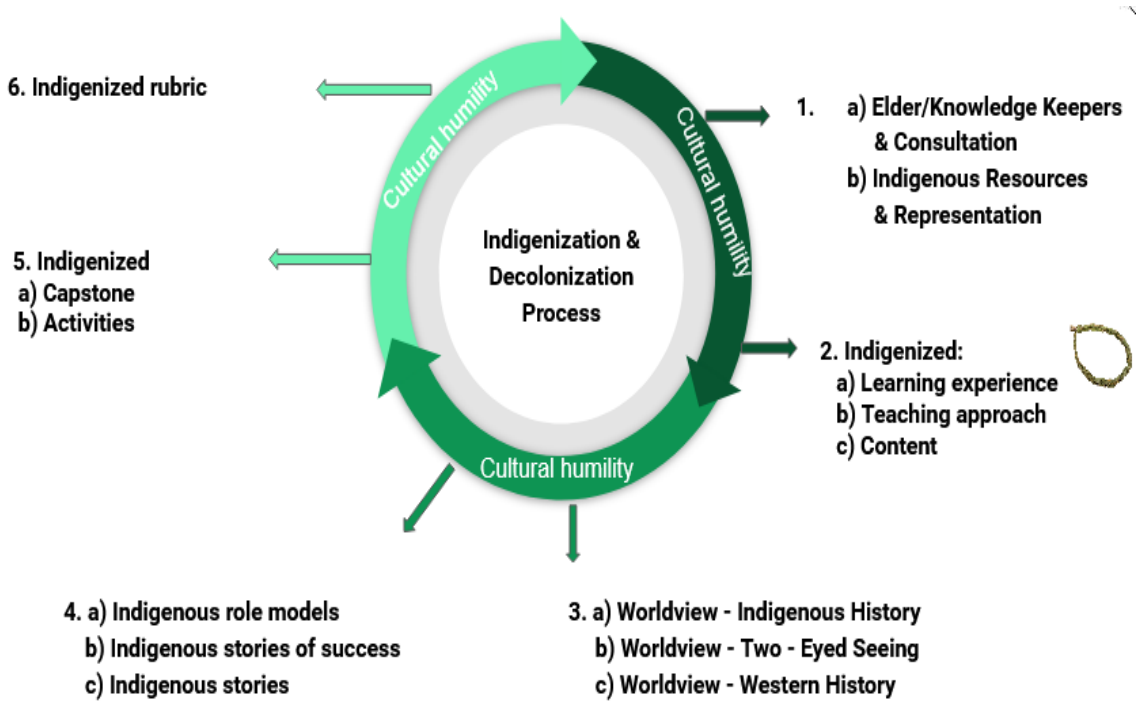


Figure 3. 3: Indigenization and decolonization process (Capilano University, 2021).

The essential concepts of an Indigenist paradigm for conducting respectful and safe research with both their own people and other Indigenous cultures have been revealed throughout the Americas, Africa, and Australasia. The entire research process must be recast and reframed from an Indigenous methodological perspective (Rigney, 1997; Weber-Pillwax, 2001; Martin, 2008; Kovach, 2010; Chilisa, 2012; Kite & Davy 2015). A decolonising and indigenizing research methodology is a method of challenging Eurocentric research methods that ignore marginalized population groups' local knowledge and experiences (Martin, 2017).

As per Goduka (2012), in order for research to be relevant and so improve the quality of life of indigenous people, it must be guided by indigenous worldviews, cultural values, and a language that is relevant to the indigenous group with whom it is performed. It should also be fed by fruitful discussions about knowledge systems, how they confine and exclude various forms of data, and what activities are required to make these structures more open and interconnected. Research that is done 'to' and 'about' Aboriginal people, rather than 'with' and, more ideally, 'by' Aboriginal people, has long been a source of pain for First Nations communities in NSW, Australia, and around the world (Dreise, 2016.) To put it another way, Aboriginal people were either unintentionally or unwillingly subjects of study during the majority of post-colonial Australia. In light of this, Aboriginal academics have followed an agenda of empowering Aboriginal communities in research in recent decades, including in Africa. For example, Jackson-Barrett et al. (2015) describe the growth of Aboriginal researchers, research methodologies, and Indigenous research agendas that have aimed to decolonize and empower Aboriginal communities through research and assessment.

Indigenous academics such as Smith (1999) in New Zealand have championed the pursuit of Indigenist research agendas in colonised countries (such as Australia, New Zealand, the United States, and Canada). Smith (1999:117) claimed in her foundational work on decolonising research that Indigenous research must be viewed through the lenses of self-determination, healing, decolonization, and transformation of political landscapes and discourses, as shown in Figure 3.4 which is her model below:

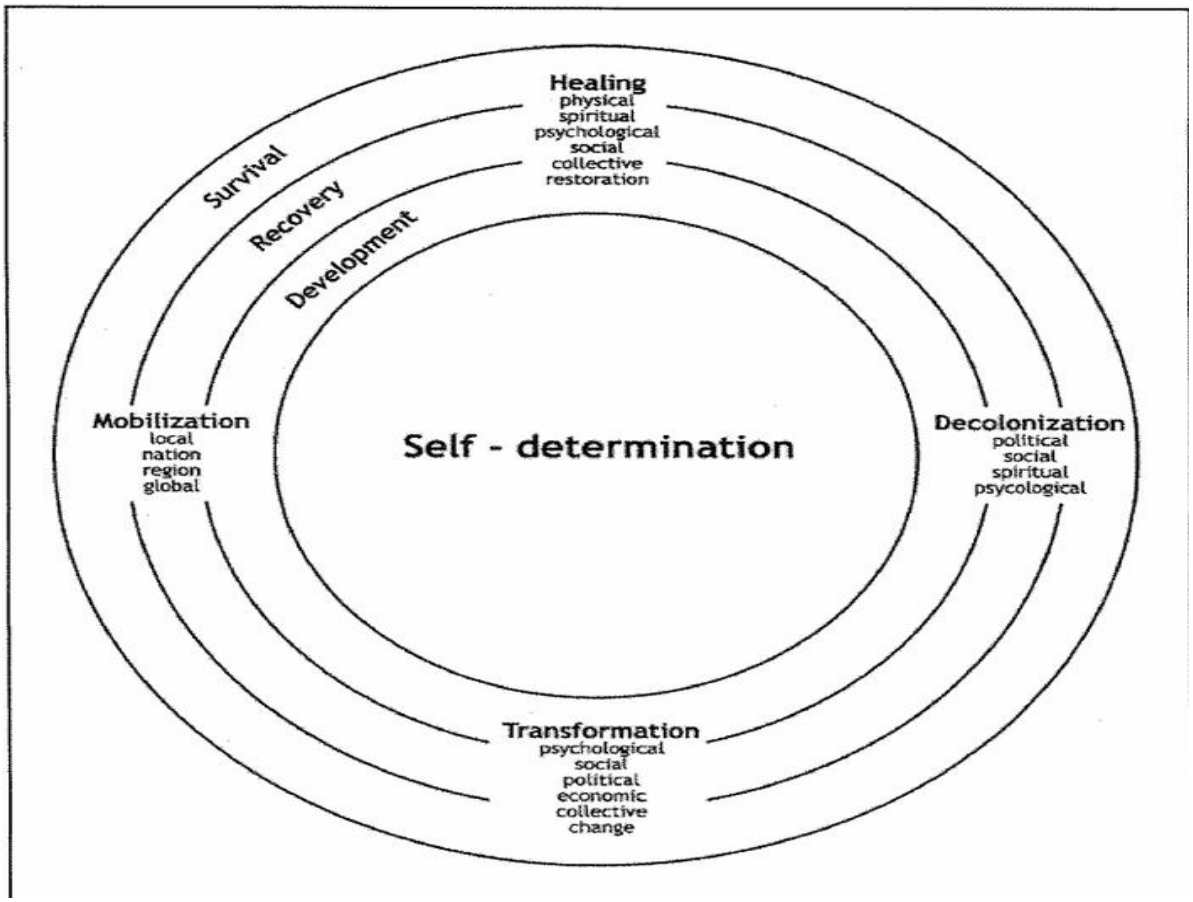


Figure 3. 4: The Indigenous Research Agenda (Smith, 1999: 117).

Indigenous activists and scholars are progressively transforming neglected communities into centers of resistance and hope, despite a long history of Western researchers claiming ownership of Indigenous knowledge and creations and disregarding Indigenous peoples' claims to self-determination (Collin et al., 2018; Smith, 2012). This opposition to colonial practices and European imperialism has paved the path for pioneering academics and Indigenous voices to call for the decolonization of research. Smith's (2012) seminal book on decolonizing methodologies defines decolonization as "a process which engages with imperialism and colonialism at multiple levels"; it points out that for researchers, "one of those levels is concerned with having a more critical understanding of the underlying assumptions, motivations and values which inform research practices" (Smith, 2012: 606).

3.2 Indigenous philosophical underpinnings of this study

This section contains literature on African indigenous philosophies, with a focus on indigenous worldviews, Ubuntu philosophy, indigenous research methodologies, and

indigenous research paradigms, which are the foundations of indigenous research decolonization and indigenization (Chilisa, 2012; Smith, 1999). The study argues that African indigenous philosophies are culturally sensitive, necessitating researchers' use of theoretical frameworks that recognize, and share relational responsibility, various realities, indigenous systems, and beliefs to promote cultural reactivity.

Indigenous culture should be valued in the same way as indigenous people's worldviews, affirmative research paradigms, and methodology should be valued by non-indigenous academics. Although non-indigenous scholars do not identify as indigenous, according to Donald (2012), they can shift toward greater compassion for colonization-related historical and current battles and improve the research process, allowing indigenous researchers to use or potentially improve indigenous philosophies (Kovach, 2009; Smith, 2012). Decolonizing methodologies in indigenous research would allow researchers to use an indigenous perspective throughout the entire research process. Scholars using indigenous concepts in their research is the first step toward indigenization and decolonization.

3.2.1 Indigenous worldviews in research

Many similarities appear to exist among Indigenous worldviews (Fitznor, 1998; Hart, 2010). Indigenous worldviews originated as a result of people's strong contact with the environment, according to McKenzie and Morrissette (2003). They listed six Indigenous peoples' metaphysical ideas that have affected this relationship:

> All things exist according to the principle of survival; the act of survival pulses with the natural energy and cycles of the earth; this energy is part of some grand design; all things have a role to perform to ensure balance and harmony and the overall well-being of life; all things are an extension of the grand design, and, as such, contain the same essence as the source from which it flows (Gitchi-Munitou); and this essence is understood as “spirit,” which links all things to each other and to Creation. (McKenzie & Morrissette, 2003: 259)

Simpson (2001) listed seven Indigenous worldview principles. To begin with, knowledge is comprehensive, circular, and reliant on relationships and connections with both living and non-living creatures and entities. Second, there are numerous truths, all of which are based on personal experiences. The third point is that

everything is alive. Fourth, everything is equal. The land is sacrosanct, at fifth place. The sixth point is that the human-spiritual link is crucial. Humans are the planet's seventh most significant resource. These and other Indigenous worldview arguments, it appears to me, place a strong emphasis on people and things working together to help and support one another in their interpersonal connections. A relational worldview is what this is called (Graham, 2002).

The importance of spirit and spirituality, as well as a sense of community and respectful independence, are central to a relational worldview. Communalism is a sense of belonging to a group of people brought together through familial ties and the families' dedication to it (Weaver, 1997; Weaver, 2001). Respectful individualism is a state of being in which an individual has a large deal of self-expression freedom because society recognizes that individuals should examine and act on the needs of the community rather than acting solely on their own interests. In debates on Indigenous peoples' knowledge, this is a relational worldview that is carried forward (Cooper, 2019)

Indigenous peoples have a relational worldview that stresses spirit and spirituality, as well as a sense of community and respect for one another (Hart, 2010; Absolon, 2010). Indigenous relational worldviews can be defined by the concept of the circle, interconnectedness, and a connection to place based on reverence, reciprocity, obligation, and relationships. The balance of the context (family culture community), mind (intellect, emotions, and life experiences), body (nutrition and rest), and spirit (spiritual practices and instruction) are emphasized in the relational worldview, as shown in Figure 3.5.

Figure 3. 5: Relational worldview (Cross et al., 2011).

To begin to comprehend the perspectives of Indigenous and Traditional Peoples, people must first comprehend their own worldviews (Martin, 2017). Indigenous worldviews are united in their recognition of the environment's interconnectivity and right to life, which contrasts with the reductionist Western viewpoint (Cajete, 2000; Johnson 2012; Johnson, 2016). These perspectives are said to as endemic or unique (Mustonen, 2014). They are frequently non-global modes of thought that have inherent values. The primary distinction is that Indigenous and Traditional Peoples position humans within the system and actively participate in it, whereas the Western system sets individuals outside of the system and regards it as something to be controlled, as seen in Figure 3.6.

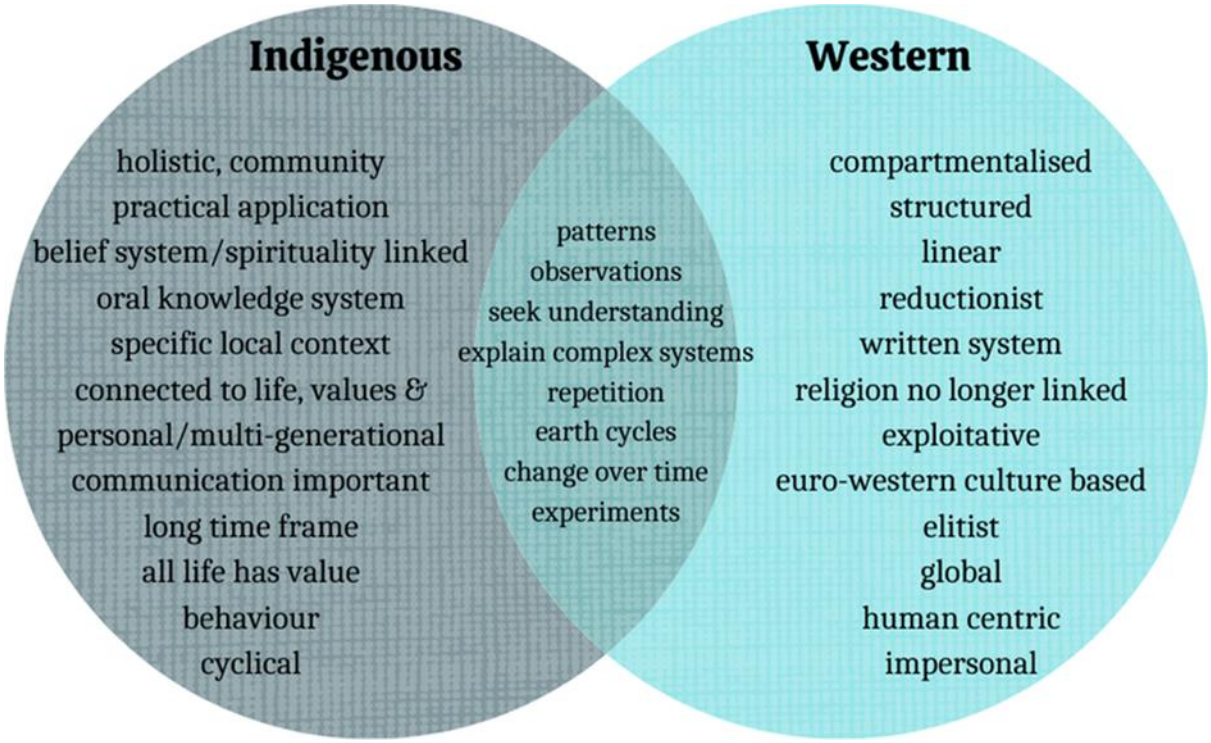


Figure 3. 6: Comparisons of Indigenous and Western Worldviews (Fischer et al, 2021)

3.2.2 Indigenous research methodologies

Indigenous research methodologies (IRM) are ones that allow and enable Indigenous researchers to be themselves while participating actively in research procedures (Weber-Pillwax, 2001). This mindset not only generates new information, but it also changes who researchers are and where they work. According to Wilson (2001), Indigenous research methodology entails discussing relational accountability, which means the researcher is fulfilling his or her relationship with the world around them. Indigenous research methodologies which are decolonizing research methodologies, for example, are essential in the development of new ways to recover control over our Indigenous ways of knowing and to restore lost ancestral teachings, values, and aspirations (Laenui, 2000; McGuire–Kishebakabaykwe, 2010). This requires a "long-term process involving the bureaucratic, cultural, linguistic and psychological divesting of colonial power" (Smith, 1999: 98).

Incorporating IRM into colonial academic institutions has received a lot of attention in the literature (Windchief et al., 2018). Leading researchers who propelled IRM to the fore include Absolon (2011), Chilisa (2012), Kirkness and Barnhardt (1991), Kovach (2009), Lavallée (2009), Rigney (1999), Smith (2012), Steinhauer (2002) and Wilson (2008). They delivered crucial critiques of the colonial academic institutions, which

they intended to alter, while highlighting the strengths and importance of IRM. To be sure, confronting colonialism in academia demands the use of Indigenous knowledge, values, and language, given the environment that creates colonial discourses as 'real' knowledge.

Indigenous scholars began to fight academia's colonial mistrust and prejudice of Indigenous knowledge by adopting research methods that respect Indigenous knowledge and ways of being (Smith, 2012). Instead of being passive objects and victims of colonial research agendas, their efforts culminated in a major positional change in which Indigenous scholars began leading Indigenous research rather than being passive objects and victims of colonial research agendas (Kovach 2009; Smith 2008, 2012) This shift in perspective is significant because it creates a space where Indigenous peoples can use their unique expertise to further their own Indigenous research rather than being constrained to employ exclusively Western research frameworks in academia (Akan, 1992; Kovach, 2010).

Indigenous ways of thinking, perceiving, and accessing knowledge have long been condemned by the academic world as belonging to no existing theory (Donald, 2012) or, more often, as nativist or even illogical and contradictory rhetoric (Donald, 2012). (Smith 1999). The academic world has frequently understood indigenous techniques as a political gesture on the side of indigenous peoples in their battle for self-determination. Indigenous approaches, on the other hand, must be regarded as part of the body of knowledge about indigenous peoples and as having theoretical worth (Botha, 2011; Ray, 2012; Kurtz, 2013; Kovach, 2015).

Because indigenous research methodologies are still relatively new in Western qualitative research (Kovach, 2010; Absolon, 2011), it is important to establish what it means to call indigenous methodologies paradigmatic. The paradigm affects the outcome of procedures (i.e., why a specific way is chosen), how such ways are employed (i.e., how data is gathered), and how the data is processed and assessed in a paradigmatic approach to analysis. A paradigm, according to Neuman (2006), is a fundamental theoretical orientation and thus a technique of effect. In this method, assumptions regarding knowledge are given a lot of thought. A more realistic method is one that "does not engage in any one philosophy and reality system." (Creswell, 2003:12).

Indigenous research methodology underpins indigenous epistemology and ontology. It expresses a reciprocal link between the researcher and the researchers who must become "a family": they are mutually interconnected within the context of the one-of-a-kind research endeavor in which they are involved. Indeed, one of the most essential parts of indigenous methodology is epistemology, which deals with ways of knowing, particularly in relation to the boundaries and validity of knowledge (Neuman, 2017). In indigenous research, the application of indigenous ontologies that deal with assumptions about the existence and linkages of being and truth may bring up fresh viewpoints that differ from those familiar and scientifically accepted in Western research. Finally, indigenous axiologies that deal with the existence, types, and parameters of values and value judgments are critical for indigenous techniques, particularly in terms of research ethics (Henry & Pene, 2001).

This study expands on Porsanger's (2004) insight of Indigenous research methodology as founded in Indigenous ways of knowing, being, and doing. In the Western canon, phenomenology is tied to the lifeworld. Its contribution to research is its focus on the subjectivity of lived reality. The lifeworld, according to Husserl (1970), is the taken-for-granted of people's embodied realities. However, this seeming constancy reflects the social and cultural contexts in which those experiences occurred, rather than observable realities. Our life as humans is constantly contextual. Our lived experience is inextricably linked to the social, cultural, and physical world in which we live, and our perceptions of it are formed by our position in it. As a result, people interpret and make meaning through embodied phenomena like touch, memory, imagination, and social interactions, all of which are impacted by people's cultural and social backgrounds.

3.2.3 Indigenous research paradigms

Indigenous research paradigms (IRP) force other paradigms to rethink how research is done with, by, and for Indigenous peoples. It also places Indigenous ways of knowing and being (such as the Cree (Wilson, 2008), Okanagan (Cohen, 2001), Métis (Marsden, 2006), Talthan (Thompson, 2008), and Maori (Smith, 2000) at the centre of the research. An IRP distinguishes itself from other research methods by clearly defining research from the standpoint of Indigenous peoples and their ways of knowing and understanding. In terms of epistemology, the interaction between the researcher and the knowledge holders is necessary to ensure that all groups' points of view are

fairly reflected (Barnes, 2018). Indigenous scholars such as Kovach (2009), Aluli-Meyer (2006), Hart (2010), and Wilson (2008; 2003) have argued that we must move beyond Western research paradigms that focus on Euro-Western knowledge; Indigenous research processes must honor, and respect, manifest, and articulate the research tools, research questions, and process itself through an Indigenous world view. In explaining indigenous research paradigm, Wilson (2001) stated that:

> An Indigenous paradigm comes from the fundamental belief that knowledge is relational. Knowledge is shared with all creation. It is not just interpersonal relationships, or just with the research subjects I may be working with, but it is a relationship with all of creation. It is with the cosmos; it is with the animals, with the plants, with the earth that we share this knowledge. It goes beyond the idea of individual knowledge to the concept of relational knowledge . . . [hence] you are answerable to all your relations when you are doing research. (Wilson, 2001: 177)

Decolonizing research paradigms and methodologies entails teaching Indigenous ways of knowing, using them in research, and valuing them on par with Western approaches to knowing and creating knowledge. Indigenous and non-Indigenous scholars have experimented with combining Indigenous and Western methodologies in alternative interpretive research or qualitative methods teaching, and there is a growing body of literature concerned with the justification and feasibility of conducting research at the intersection of Western and Indigenous knowledge systems (e.g., Battiste, 2000; Denzin et al., 2008; Gerlach, 2018; Getty, 2010; Knudson, 2015; Kovach, 2010; Mertens et al., 2013). Only a few mention the paradigmatic compatibility issues that arise when two procedures, each associated with a different paradigm, are integrated (Chilisa, 2012; Chilisa, Major & Khudu-Petersen, 2017; Cram & Mertens, 2015, 2016; Kovach, 2009, 2010; Mertens & Cram, 2016). The main reason for this is that discussions about Indigenous approaches and their relationship to research paradigms are still in their early stages and are being carried out under a variety of names (Chilisa & Tsheko, 2014).

The IRP distinguishes itself from other research methodologies by identifying research from indigenous perspectives and ways of knowing and understanding. The researcher's interaction with the rights holders is crucial from an epistemological

standpoint to ensure that all groups' perspectives are equally represented (Pidgeon, 2019). Indigenous scholars such as Aluli-Meyer (2008), Kovach (2009), Hart (2010), and Wilson (2008; 2003) have argued that there is a need to move beyond Western science paradigms that rely on Euro-Western knowledge; indigenous research processes must honor, respect, manifest, and express research instruments, research questions, and processes through an Indigenous world view. An IRP documents the continuing interactions between researchers and knowledge holders, whether the researcher is an indigenous scholar working in his or her own territory or in collaboration with others. Scholars such as Archibald (2008), Brayboy (2000); Brayboy & Deyhle (2000) and Menzies (2004) discuss the possibility of a non-Indigenous academic engaging with Aboriginal communities in their research (Hoffman, 2013; Moffatt, 2016).

Hoffman (2013), for example, wrote in the academy on Indigenous knowledge, the interrelationship of Indigenous knowledge that pertains to time being nonlinear, and the wholistic essence of self in relation to others as a non-Indigenous researcher. Clearly, an IRP may be used by indigenous researchers to define a conceptual framework that is vital to who they are as indigenous people (Aluli-Meyer, 2006; Wilson, 2008; Kovach, 2009; Hart, 2010; McIvor, 2010; Smith, 2012; Prete, 2019). It also considers the roles of the Aboriginal communities with which they interact, as well as cultural etiquette, requirements, and conditions, thus reason is critical to an IRP's success. The role of ethnic consciousness to the IRP is explicitly defined by Kovach (2009).

Relational epistemology emphasizes the transactional and embedded nature of knowing. According to Martin and Mirraboopa (2003), rather than being an objective observer of reality, people are a component of reality that shapes it. To put it another way, it's hard to distinguish between the knower and the known, who are both informed by a variety of cosmos-related relationships (Hart, 2010; Kovach, 2010; Chilisa 2012). When presenting a knowledge argument, African epistemology considers what the African says and knows. This relates to the way Africans interpret and communicate information (Kovach, 2010). According to Chilisa (2012; 2017), the views on Figure 3.7 are linked to an indigenous research paradigm. The diagram depicts the relationship between the components and concepts that underpin the indigenous research paradigm. The components listed below can be used as a starting point for

doing research with indigenous peoples. The components and beliefs also explain the interconnection of traditional African knowledge and its comprehensive nature. As a result, an indigenous research paradigm "argues for the reassertion and reconstruction of traditional knowledge from its roots, its essential principles" (Garroutte, 2003: 101).

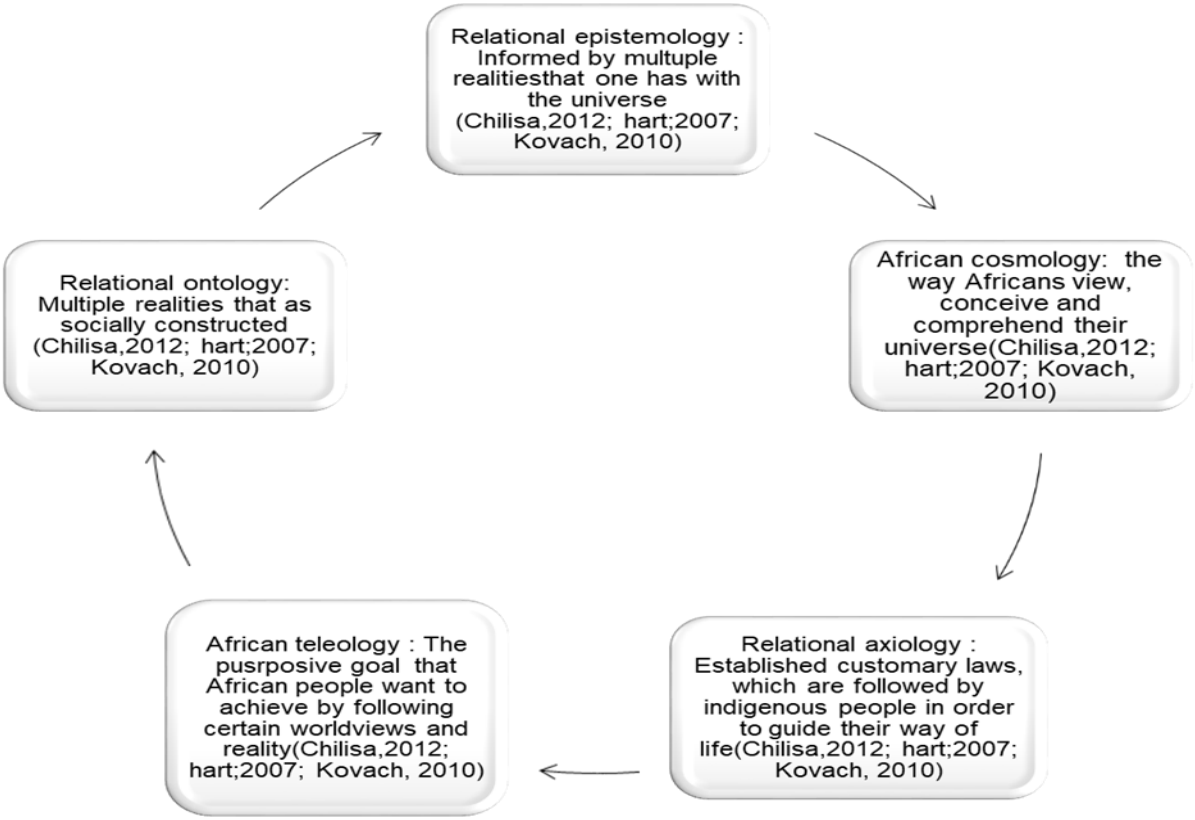


Figure 3. 7: Indigenous research paradigms and it's components (Bhuda, 2019).

In-depth, relational ontology explores how people's relationships with the environment, the cosmos, the living, and the non-living are arranged to create multiple socially constructed realities. African peoples' senses and beliefs are addressed by relational ontology (Chilisa 2012; Hart, 2010; Kovach, 2010). Relational epistemology emphasizes the transactional and embedded nature of knowing. According to Martin and Mirraboopa (2003), rather than being an objective observer of reality, we are a component of reality that shapes it. To put it another way, it's impossible to tell the difference between the knower and the known, who are both informed by a set of varied relationships with the cosmos (Hart, 2010; Kovach, 2010; Chilisa 2012). When a knowledge argument is made, African epistemology considers what the African says and knows. This refers to how Africans interpret and communicate facts (Kovach, 2010).

African cosmology depicts how the Afrocentric concept communicates to Africans the fundamental meaning of the world's dimensions, purpose, and function, as well as the natural context in which it was created (Hart, 2010; Kovach, 2010). It's simply how Africans perceive, conceptualize, and comprehend their universe; the core lens through which they view reality, influencing their belief systems and cognitive dispositions (Chimakonam, 2012; Kanu, 2013; Jaja, 2014). Relational axiology describes how Indigenous people adhere to procedures that guide them down the path to the life they desire. They respect the living world, the non-living world, and the heavenly world. Relational axiology encompasses the characteristics of morality and ethical excellence, such as values, standards, convictions, and models. The main purposes that direct African people to follow certain world views, protocols, principles, and truth are referred to as African teleology. The notion in African teleology is that people's ways of living, studying, and doing things change towards a common goal (Chabalala, 2018)

The indigenous research paradigm, according to Martin and Mirraboopa (2003), recognizes Indigenous peoples' methods of doing, which are articulations of ways of knowing and ways of being. Languages, art, images, technology, rituals and ceremonies, land management methods, social organization, and social control all exhibit these characteristics. indigenous peoples (Martin & Mirraboopa, 2003). Individual and group identities, as well as individual and group roles, are expressed through ways of behaving. Indigenous people's acts and conduct are a result of their subsequent progress and growth on individual Ways of Knowing and Being (Ibid, 2003). They become physical proof of ontology and its development of their Ways of Being and Ways of Knowing, according to (Dew et al., 2019). That is, they may demonstrate (Do) what they know (Knowing) in a courteous and appropriate manner (Being), as seen in Figure 3.8.

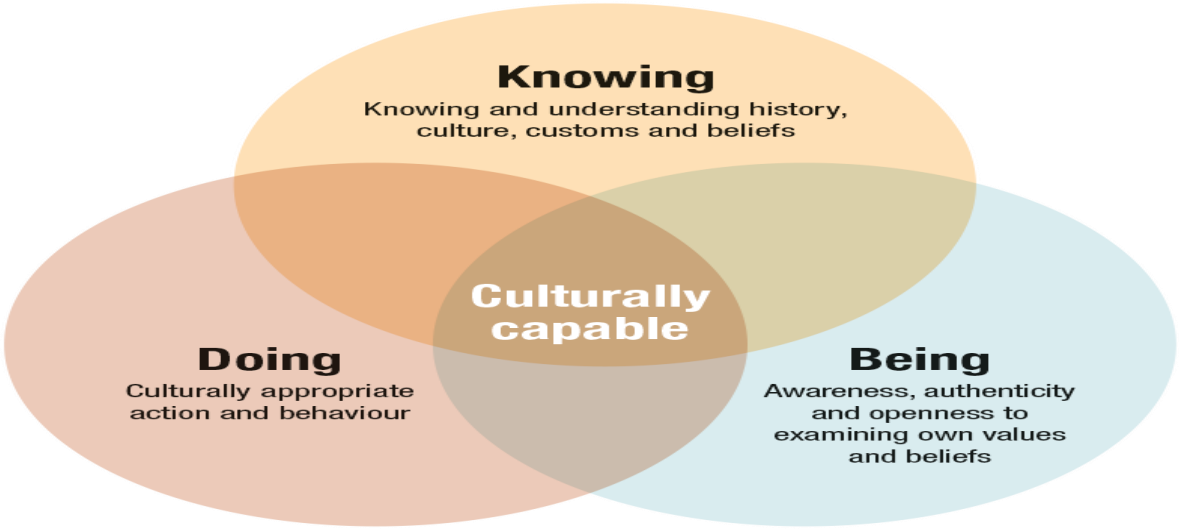


Figure 3. 8: Cultural capacity framework (Goerke et al., 2015)

Indigenous ways of knowing and structures for knowledge production have been developed, used, and refined for millennia (Cajete, 2000; Shroff, 2000; Wilson, 2008; Chilisa, 2012; Okalik, 2013). Nonetheless, under colonial control, research became one of the dirtiest phrases for indigenous peoples (Smith, 2012), as they were among the most investigated human groups (Rigney, 1999; Smith, 2012). Natural scientists, especially indigenous scholars, can now conduct studies with indigenous communities while adhering to customary norms, which do not harm the people, thanks to indigenous ways of knowing in research as shown in table 1.

Table 3. 1: Ways of knowing in Indigenous research (DeMarrais, 1998).

	Archival knowing	**Narrative knowing**	**Observational knowing**	**Relational knowing**
	People's artefacts	People's stories **Own stories**	People's behaviours	**People's shared learning & understanding**
Methodological approach	Historical research	**Narratology Autobiography** Oral history	Ethnography **Participation** Action research **Listening**	**Transformation research** Intuition/listening Co-creating **Participation of researcher and community Sharing, 'studying-up'**
Data source	Letters, newspapers, photographs, tools, objects	In-depth interviews, **stories**, songs	Participant observation, field notes, participant assignments	Dialogue, community discussions, ceremonies, meeting notes

3.2.4 Ubuntu philosophy in indigenous research

Ubuntu is a philosophy that stands in opposition to the individualistic and utilitarian ideas that are widespread in the West. It's a Zulu/Xhosa/Ndebele word that's related to 'humanness' in many other African languages. The Nguni proverb 'umuntu ngumuntu ngabantu,' which means 'a person is a person through other people,' may best describe its meaning. Although the Bantu peoples of southern Africa are said to have originated the philosophy of Ubuntu, it is now practised across most of the continent. It is best described as a social philosophy founded on the ideals of care and community, harmony and hospitality, respect and responsiveness, and that expresses the underlying interconnectivity of human existence (Mabovula, 2011).

Ubuntu is a relational philosophy, with statements like "I am because we are" alluding to a constructivist ontology in which a person's sense of self is intimately related to their social context. It emphasizes the necessity for a subjective and emotional knowledge of human experience rather than objectivity and rationality. An Ubuntu perspective on research necessitates an interpretivist epistemology that favours qualitative approaches that allow for inductive knowledge of how individuals and groups make sense of the world. While this technique is very widespread in the field of action research, it contrasts sharply with the positivist paradigm that dominates much social theory and research (Mdluli, 1987; Letseka, 2013; Eliastam, 2015).

Ubuntu, according to Mugumbate and Nyanguru (2013), is defined as an inclusive strategy that promotes dignity and respect in our interpersonal relationships. This technique shows a preference for participatory and cooperative inquiry in research, in which the researcher develops a close relationship with participants and actively involves them as co-investigators in the study's design, conduct, interpretation, and implementation. It is also a good fit for asset-based approaches like appreciative inquiry, which emphasize the importance of recognizing and building on assets rather than focusing on how to fix faults (Metz, et al., 2010).

Indigenous societies are built on the ideals of Ubuntu. Respect, communalism, interdependence, support, solidarity, collaboration, caring for others, empathy, environmental support, and participation in the common good are among these principles (Hamminga, 2005; Khupe et al., 2010). Ubuntu is the foundation of the African worldview (Broodryk, 2006). Ubuntu is a word that means "humanity" or "human being" (Mdluli, 1987). Ubuntu is "...a philosophy that sees human needs,

interests, and dignity as of fundamental relevance and concern" (Venter, 2004), emphasizing relationships and nurturing the good of society (Higgs, 2008:452).

Ubuntu is founded on a care for others' well-being, as evidenced by reverence, communalism, compassion, generosity, fairness, caring for others, and participation in the common good, among other things (Hamminga, 2005). Ubuntu (Venter, 2004) is characterized by an African perspective (Venter, 2004). It emphasizes a person's humanity in direct relation to other people, and it has upbeat overtones of encouraging and demonstrating compassion and support for others (Louw, 2004).

Ubuntu promotes researchers to consider about others' well-being in their research, as evidenced by respect, communalism, compassion, liberality, trustworthiness, kindness in thinking about others, and engagement for the greater good (Hamminga, 2005). This will result in positive interactions with indigenous peoples. In Africa, Ubuntu is a necessary component of one's worldview (Venter, 2004). It promotes self-understanding primarily in connection to others, rather than as being 'independent' of others (Kamwangamalu, 1999). The elements of the Ubuntu concept in research are depicted in Figure 3.9. It serves as a guide for academics conducting indigenous research with indigenous communities. Ubuntu as a research paradigm indicates that research methodology, agenda, and ethics are all based on Ubuntu's epistemology, ontology, and axiology. That is not to say that all aspects of Ubuntu research in other frameworks are fundamentally different from or contradictory to practices. In certain cases, indigenous methods may be a blend of indigenous customs and established methods that have been adapted to the setting (Smith, 1999). The motivation and mindset of a researcher determine if and how common ground may be discovered between traditional and Ubuntu approaches (Swanson, 2012).

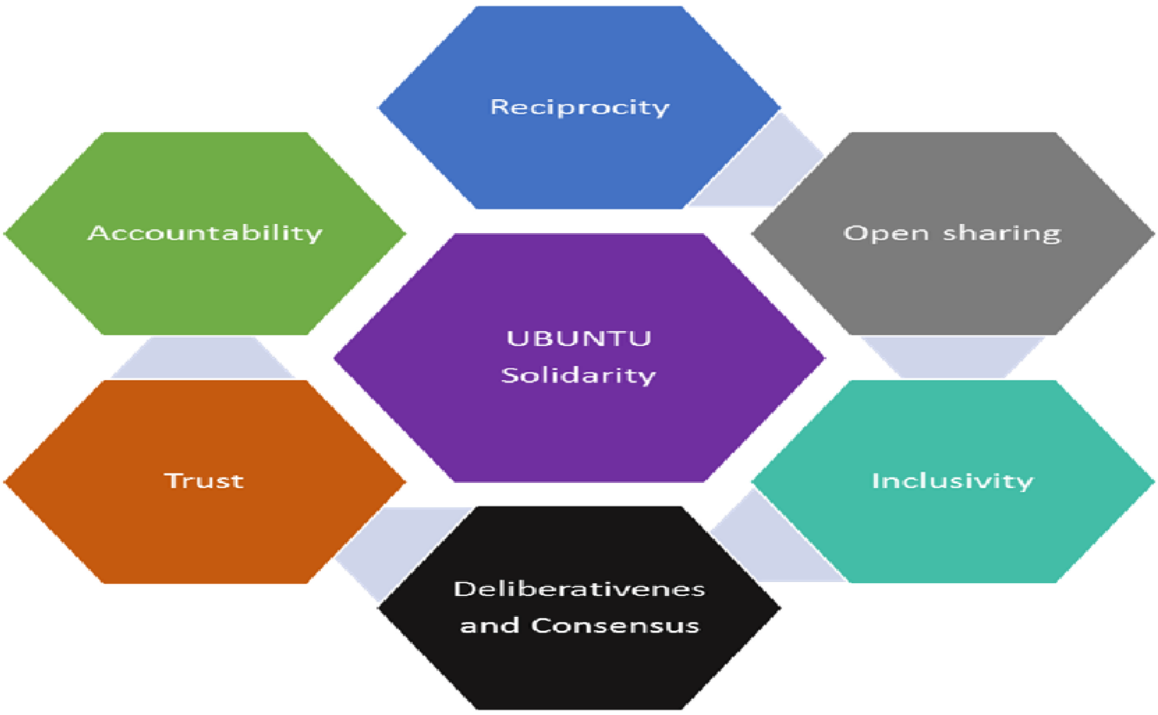


Figure 3. 9: Principles of Ubuntu philosophy (Munung et al., 2021)

3.3 Policies and legislations supporting the protection and preservation of indigenous knowledge and Indigenous Knowledge Systems

The study was underpinned by specific policies and legislations (statutory sources) that promote indigenous research and advocate for the preservation, diffusion, and protection of Indigenous Knowledge Systems. Policies protecting traditional cultural expressions or indigenous knowledge systems, on the other hand, are not restricted to those included in this section. The policies and legislation chosen for this study directed the researcher through the research process, whereas those offered in Chapter 7 clarify further how traditional cultural expressions such as artefacts are protected, preserved, and disseminated in South Africa. As a result, the following principles guided this study:

3.3.1 IKS policy of 2004

According to the Indigenous Knowledge Systems (IKS), there needs to be the affirmation of African cultural values in the face of globalization, a clear imperative given the need to promote a positive African identity. The policy further states that the Integrating and celebrating of African perspectives in South Africa's knowledge systems is not only a matter of redress. It should help create new research paradigms

and mental maps that aim to decolonize research on IKS. The policy is against the backdrop of centuries of oppression, exists an indisputable wealth of IK that has survived and, in some cases, and has even grown within the protective confines of African societies and communities.

The Indigenous Knowledge Systems (IKS) developed and maintained by South Africa's indigenous peoples which pervades their lives, and the belief systems should be respected and honoured. Such indigenous knowledge is complex and has manifested itself in areas ranging from cultural and religious ceremonies to agricultural practices and health interventions.

3.3.2 IKS Act of 2019

The Indigenous Knowledge Systems Act provides for the protection, promotion, development, and management of indigenous knowledge. It provides for the establishment and functions of the National Indigenous Knowledge Systems Office (NIKSO). It further provides for the management of the rights of indigenous knowledge. The IKS act provides for the Act to protect IK, whether it is functional or cultural, or both, including medical, agricultural, or scientific practices. IK is regarded as property as defined in section 25 of the Constitution. The IKS Act supports the National Indigenous Knowledge Management System (NIKMAS) which supports the processes and structures developed through the National Recordal System (NRS) and is responsible for the recording, storing, management, and dissemination of Indigenous Knowledge (IK).

3.3.3 The South African national language policy of 2003

The South African national language policy acknowledges the fact that several indigenous languages are spoken across provincial borders; spoken by speaker groups from different provinces. Section 6(2) of the Constitution includes frameworks for the development of those indigenous languages. Currently, there is a growing understanding of the need to step up efforts to improve the historically marginalized indigenous languages and encourage multilingualism to free South Africans from undue dependence on the use of non-indigenous languages as the state's dominant official languages.

The Policy Framework aims to protect, preserve, and promote the indigenous languages of South Africa. This could be accomplished in a variety of ways, including conducting studies about indigenous languages, and conducting research with

indigenous communities that embraces their native languages. Recognizing the historically low use and status of people's indigenous languages, the state must take real and meaningful steps to raise and advance their use. The Department of Education and the then Department of Arts, Culture, Science and Technology translated these words into policy. Despite the gravity of this milestone in terms of decisions and policies.

3.4 Conceptual framework of the study

AmaNdebele is Indigenous people of Southern Africa, which belong to the large Nguni ethnic group. As stated, (cf.1.7), the South African AmaNdebele are categorized into two and they are currently situated in Mpumalanga and Gauteng (Ndzundza Mabhoko and Manala group) are Southern Ndebele and Limpopo (BagaLanga and the BagaSeleka groups) who are Northern Ndebele (Jackson, 1969). The AmaNdebele believe that their use of mathematical artefacts began when they started existing and according to their beliefs, Supreme Beings influenced the cultural expression. In the 19th century, the Southern AmaNdebele lost a war to the Dutch speaking Boers and soon after, their mathematical artefacts started developing, highly expressed, and used. However, they have been existing before the 16th century but became greatly expressed after the war. It was believed that this was the intructions from their ancestors to communicate using the mathematical artefacts and develop them to express their pain but also to unite the people. The AmaNdebele sophisticated mathematical artefacts are found in beadwork and mural art and serve as an ethnic identity and cultural expression. AmaNdebele use their artefacts mostly during ritual ceremonies and annual commemorations. Women are responsible for the cultural expression and identity using mathematical artefacts. It is believed that the supreme beings of the AmaNdebele communicated through diviners, instructing them that AmaNdebele women should be custodiance of the knowledge. Over the years, the AmaNdebele women have established strategies to protect the knowledge of mathematical artefacts and to preserve it for the future generation. The protecton and preservation of Indigenous knowledge has been advocated by the South African Department of Sports, Arts and Culture and the Department of Science and Technology.

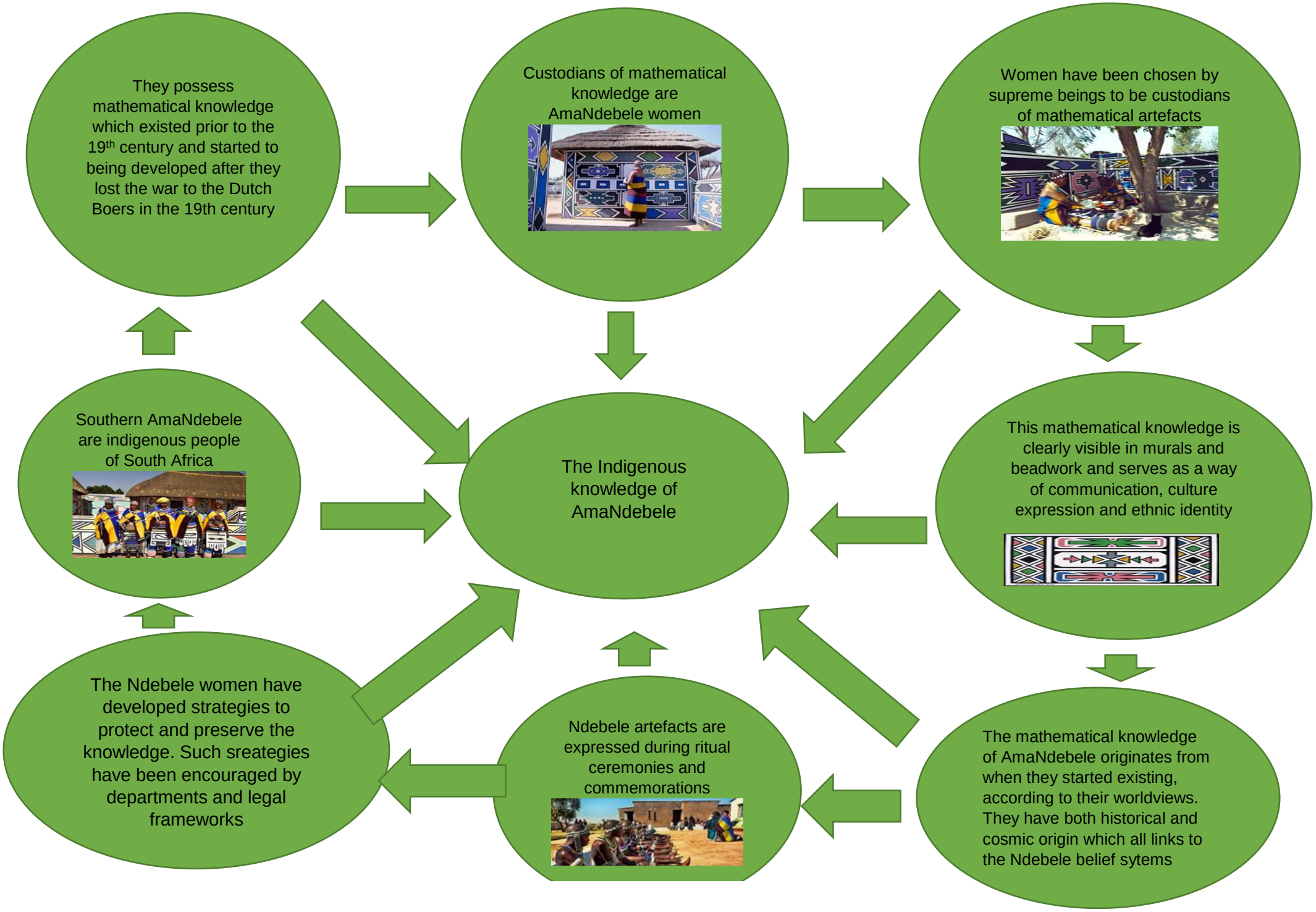


Figure 3. 10 : The conceptual framework of the study

3.5 theoretical framework of the study

This study is underpinned by three theories namely: eZiko, Sipheka Sisophula, Indigenous theory and Afrocentricity theory.

3.5.1 eZiko Sipheka Sisophula

Eziko Sipheka Sisophula by Goduka (2005) is rooted in indigenous worldviews, philosophical foundations, cultural values, and languages, and have relevance for teaching and researching for the improvement of the quality of lives within indigenous contexts. eZiko also provides a holistic, feminine, experiential, participatory, collective, communal, and integrative methodology. Eziko derived from the African design of a circle. Based on this design, African life moves in a cycle that is perceived from a circular perspective. A circle is additionally learning space around which intercultural and intergenerational discoursed happen in a spirit of connectedness and respect.

Inside curricula, pedagogies and research methodologies, eZiko looks to de-colonize Western-based knowledge, worldviews and questions the pertinence of Western and colonial positivist approaches for tending to sustainable advancement and indigenous knowledge inside rural settings. In this manner, eZiko Sipheka Sisophula as a theoretical framework points to recuperate, re-establish, recognize, and recreate and 'research back' utilizing indigenous African epistemology, axiology, philosophy and rationale, and social philosophy, teleology and cosmology as methodological develops (Manyike & Shava, 2018).

This theory is critical for this study because it assisted the researcher in understanding the AmaNdebele cultural values, identity and the rituals and teachings involved in preserving the AmaNdebele identity. It will also enable the researcher to gain insights on communal participation, and collectiveness in maintaining the AmaNdebele identity through using mathematical artefacts. Because it is feminine, it assisted the researcher to understand the role of women in preserving the AmaNdebele identity using mathematical artefacts. It also enabled the researcher to understand the relationship between the spiritual world and how this knowledge is shared from the spiritual realm to the physical world using the concept of the African design of a circle.

3.5.2 Indigenous theory

The Indigenous theory is rooted in indigenous people's beliefs, worldviews, knowledge, and culture (Kim & Berry, 1993). It is established intimately within indigenous epistemologies, worldviews, beliefs, and traditions. The Indigenous theory

is holistic and multilayered, incorporating the social, emotional, intellectual, and physical aspects of being. The Indigenous theory is an ancestral concept to Indigenous people derived from the teachings of the land, sun, water, sky, and all of Creation. Its' methodologies of practice integrate the natural teachers and elements of the universe (Kim & Berry, 1993).

This theory emphasizes Indigenous decolonization and challenges western ways of interpreting indigenous knowledge systems. It advocates for appropriate research techniques on African Indigenous Knowledge systems while criticizing previous work that did not represent the worldviews of African people. For this study, this theory was relevant because it guided the researcher to use an indigenous lens and appropriate research methods suitable for indigenous research in order to understand the worldviews of the AmaNdebele and cultural beliefs regarding the origin of their mathematical artefacts. This will be done in a manner, which represents the custodians of the knowledge, their beliefs and worldviews.

3.5.3 Afrocentricity theory

Afrocentricity theory by Asante (1980) centres on the history of people of recent African descent. It is in relation to the reaction to worldwide (Eurocentric) attitudes about African people and their historical contributions. It looks to redress what it sees as mistakes and concepts propagated by the supremacist philosophical underpinnings of western scholarly disciplines as they created during and since Europe's Early Renaissance as defending the bases for the oppression of other peoples, in order to empower more exact accounts of not only African but all people's contributions to world history. In this way, indigenous research is a development that comes from an Afrocentric point of view and the call to decolonize (especially scholarly) knowledge approval and representation. Afrocentrists contend that research strategies have to be be made to adjust with the intentions, context, and participatory nature of IK (Asante, 2000).

The Afrocentricity theory aims quality of thought and behavior that is anchored in African people's cultural image and interests, and reflects African people's living experiences, history, and traditions as the centre of analyses. The idea of the African identity as rooted, and centered in African culture in all aspects – spiritual, social, political, and economic – is at the heart of Afrocentricity theory. It is an assessment of African reality from an African viewpoint; one that prioritizes the African experience,

acknowledges the African voice, and reinforces the relevance of cultural experience as a starting point for developing a dynamic multicultural research strategy (Mkabela 2005).

This study seeks to understand the historical and spiritual origins of AmaNdebele mathematical artefacts, guided by the tenets of Afrocentricity theory. The theory directed the study to gain a deeper understanding of the genesis of mathematical artefacts according to the oral history and beliefs of the AmaNdebele. It also allowed the researcher to gain insights of AmaNdebele's worldviews and cultural mathematical knowledge without imposing any external knowledge. The people's perception of the history of mathematical artefacts in the AmaNdebele culture is important for indigenous study. This is due to the long-standing imposition of Eurocentric worldviews on African history and culture. As a result, indigenous voices can be at the center of research, and indigenous people can own their knowledge and cultural experience in every way.

3.6 The Integration of African philosophical underpinnings of the study

Ubuntu philosophy, Indigenous worldviews, Indigenous research paradigms, indigenous research methodologies, eZiko, Sipheka Sisophula theory, Indigenous theory and Afrocentric theory were used to guide this indigenous research constituted the methodological framework for this study. These African philosophies assisted in identifying the Mathematical knowledge that the people of KwaMsiza, Mabhoko community have, the worldview that underpins their knowledge and the origin of such knowledge. The integration of African philosophies was done in order to show that this is indigenous research that is conducted by an indigenous scholar working with indigenous communities. The integration of African philosophies was a way of showing that this is decolonized research that is guided by African ways of knowing, doing and being. Thus, it was important to integrate the African philosophical underpinning of the study in order to form an integrative research framework. The integration occurs in a setting that is made special by the transaction of social, historical and social factors, especially relevant to this community, prompting the development of specific knowledge and understandings of reality negotiated through language.

3.7 Indigenous research framework underpinning this study

The researcher synthesis the framework presented below in Figure 3.11. The indigenous research framework underpinning the study guided the research process. The framework shows how the researcher has positioned herself as an indigenous scholar and a Ndebele woman in the study. Based on the reason that the researcher has knowledge and experience of indigenous knowledge Systems, the researcher was able to conduct research that is grounded on African worldviews and worked with the community through the research process. The community was able to make fundamental decisions regarding the research process and a strong relationship was established between the community and the researcher. Guided by African philosophies, the study was able to be positioned as indigenous research, following necessary customary protocols, rooting itself in indigenous knowledge systems and using appropriate data collection research methods that are relevant to indigenous research. The presented framework illustrates how this thesis facilitated a decolonized study that positions indigenous voices and epistemologies at the core of the research process, researching with indigenous communities.

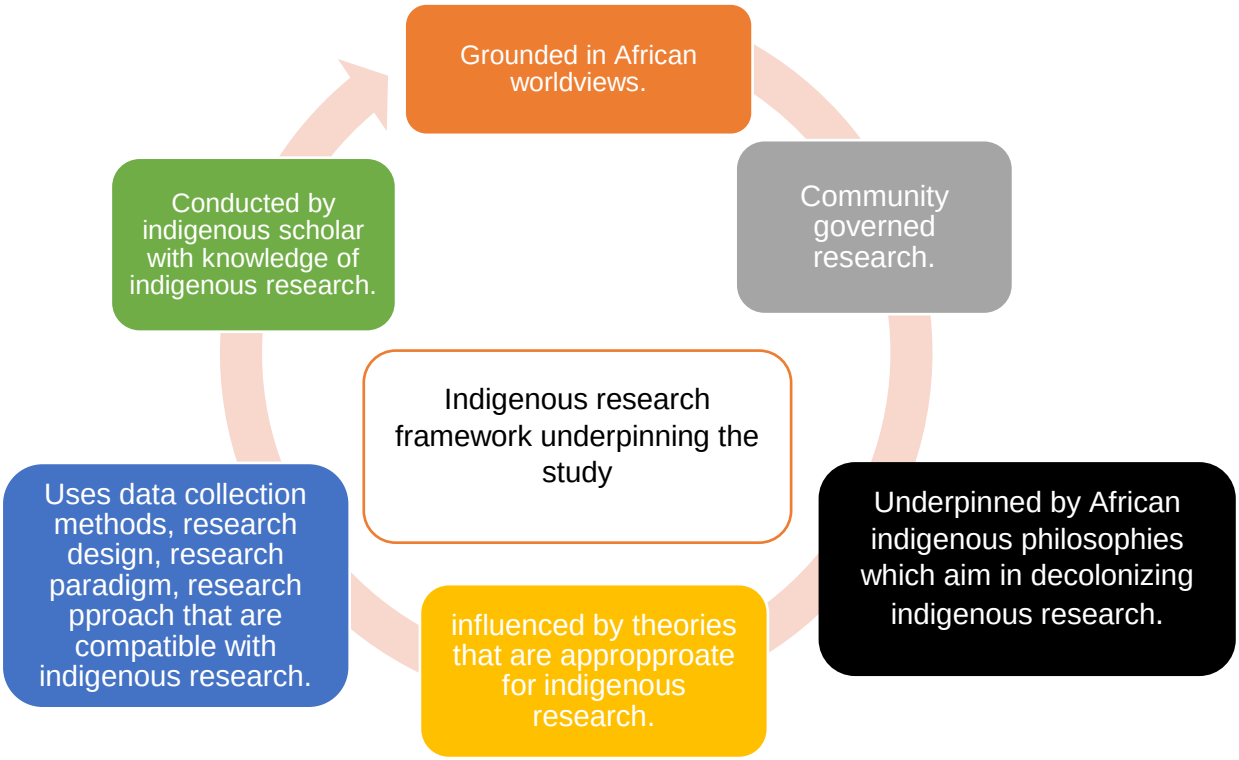


Figure 3.11: The Indigenous research framework underpinning the study (source; researcher).

In developing the framework, the researcher has used an indigenous lens for the understanding of the self as distinct but positioned within the relational-collective self. Within this framework, the researcher acknowledges the Indigenous knowledge of participants and what they constitute as their reality and worldviews. As previously stated, these African philosophies are ideal for indigenous research and as they structure and endorse the study rationale, the problem statement, purpose, significance and research questions. They will also provide the literature review with a grounding framework, and most importantly, the methods and analysis.

3.8 An Introduction to the study area.

3.8.1 An overview of the North-West Province

The North-West is situated on the Botswana frontier in the north of South Africa, bordered by the Kalahari Desert to the west, Gauteng Province to the east, and the Free State to the south. It occupies an area of 104 882 km2 and has about 3 748 436 inhabitants. The flat areas of sparse trees and grassland make up most of the province. The Vaal River flows along the province's southern boundary. The capital is Mahikeng (previously Mafikeng). The city lies close to the Botswana border and with its neighbouring town, Mmabatho forms a single urban area. The greatest cities in the province are Potchefstroom and Klerksdorp. Brits, Rustenburg, Klerksdorp, and Lichtenburg are other major cities (Statistics South Africa, 2016).

In the southern region between Potchefstroom and Klerksdorp, as well as Rustenburg and the eastern region, most economic activity is concentrated. Mining is the largest contributor to the economy of the North-West and constitutes about a quarter of the entire mining sector in South Africa. For cattle raising, the North-West is well developed, while the areas around Rustenburg and the British are fertile, mixed-crop farming property. The most important crops are maize and sunflower, and the province is the country's largest producer of white maize. According to Statistics South Africa (2016) the North-West is divided into four district councils, further subdivided into eighteen local municipalities as seen in Figure 3.12.

Tswana people who speak Setswana, are in neighbouring Botswana, are the majority of the province's population. Smaller communities include individuals speaking Afrikaans, Sotho, Xhosa and IsiNdebele. As a second language, English is mainly spoken. Christian groups belong to most of the population. 90.8% of the population of the province was Black (mostly Tswana-speaking), 7.2% White (mostly Afrikaans

00speaking), 1.6% Coloured and 0.4% Asian, according to the 2007 community survey. The 2007 population survey found that the province had just over 3 million inhabitants.

The white population of the province is distributed rather unevenly. The white percentage in dual statistics such as the Tlokwe and Matlosana in the southern and eastern municipalities, where the white percentages were 27 percent and 12 percent respectively (Ibid, 2016). The province has the lowest number of people who have earned higher education aged 35 years and older (5.9 percent), though the number of individuals receiving higher education has been rising since 1994. Many citizens moved to the economic centers of Cape Town and Gauteng after the disbanding of the Bantustans.

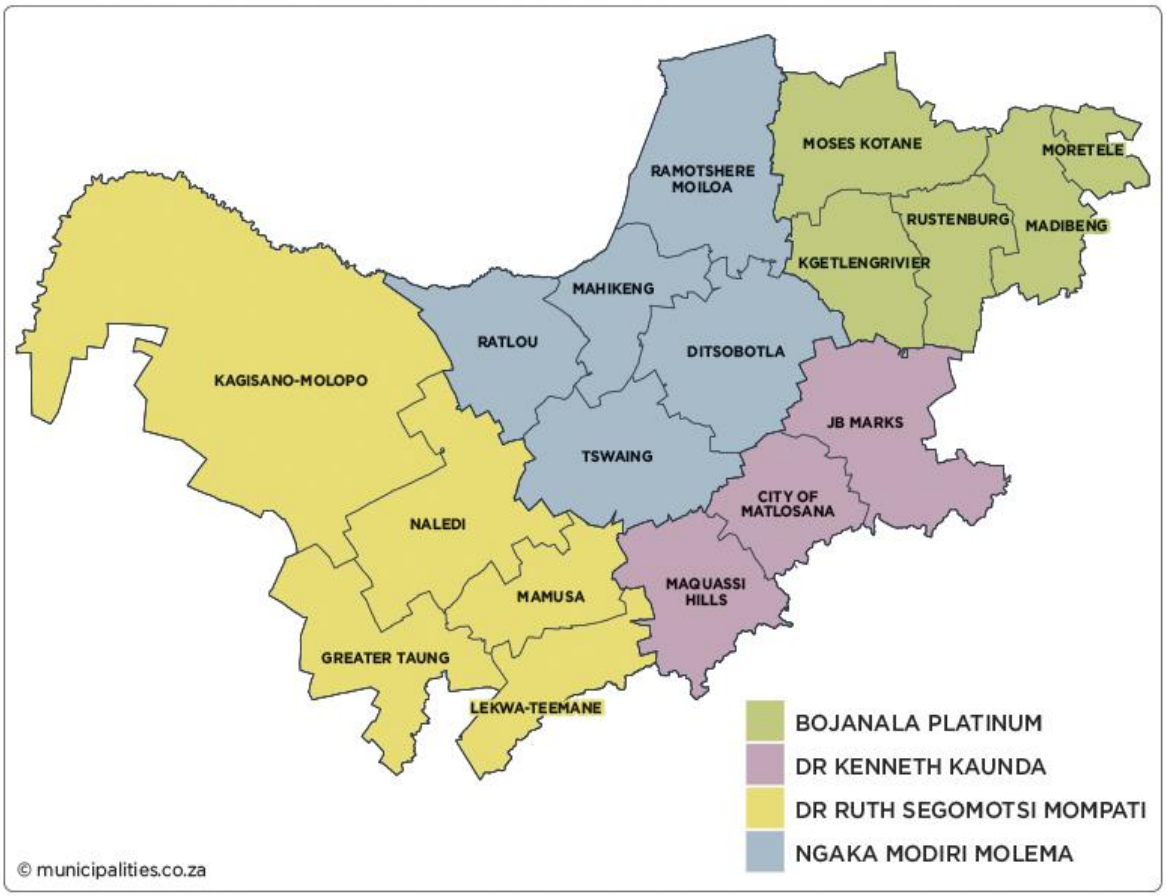


Figure 3. 12: Districts and municipalities in the North-West Province, South Africa (Municipalities of South Africa, 2017).

This study will be conducted in KwaMsiza, Mabhoko community, situated in Klipgat, Madibeng local municipality. This place is situated in Odi 1, North-West, South Africa, and its geographical coordinates are 25° 28' 0" S, 27° 58' 59" E.

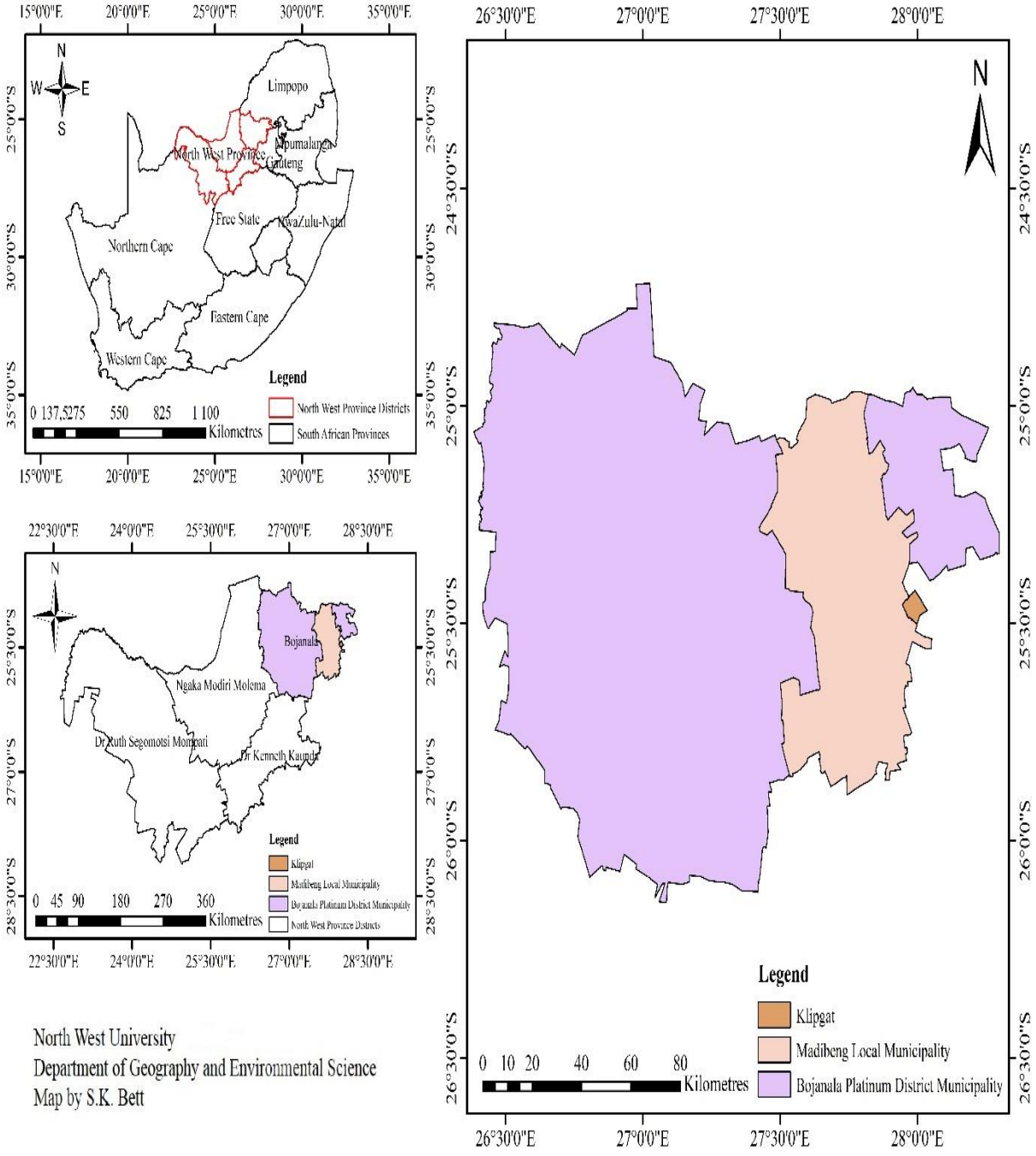


Figure 3. 13: KwaMsiza, Mabhoko community (Bett, 2020)

The Statistics South Africa (2016) shows that the Madibeng local municipality has a total population of 477,381 (124.34 per km²) individuals, 89.28% of whom are Black African, 8.94% White, 0.90% Coloured, 0.51% Indian or Asian and 0.37% Other. Klipgat has a population of 38,671 (970.85 per km²) with 51% of females and 49%

males. Languages spoken are as follows: Setswana 41%; Xitsonga 17 %; Sepedi 15% ; IsiNdebele 9%; IsiZulu 7% and Sesotho 4% (The statistics of South Africa, 2011).

Only approximately two out of every ten persons (18.8%) in North-West were born elsewhere, with about eight out of ten residents (81.2%). Gauteng (198 966), Limpopo (94 656), Free State (88 371), Eastern Cape (87 652), Northern Cape (38 393), and Mpumalanga (122 284) were the provinces with the highest number of people born outside the Nort-West (38 208). With only 22 634 and 8 872 persons emigrating to the North-West, respectively, KwaZulu-Natal and the Western Cape had the lowest numbers. Between 2011 and 2016, the province of North-West witnessed a net migration of 159 135, with 540 900 individuals emigrating and 700 035 moving in from other provinces (The statistics of South Africa, 2016).

KwaMsiza is a village of 49 families located approximately 50km north of Pretoria. Its occupants are Ndzundza Ndebele and belong to three significant family groups: the Msiza, the Bhuda, and the Skhosana. They lived initially on the Hartbeesfontein farm, at Wonderboompoort, yet when this land was dispossessed to clear a path for an airport in 1953, they were moved to the District of Odi/Klipgat, where they live to the present day (Frescura, 2009). The village/community exhibits several interesting features, including a few dwellings built in the historical verandah style decorated in geometric designs and excellent beadwork artefacts made by AmaNdebele women (Mahlangu, 2016).

3.8.2 Brief history of KwaMsiza Mabhoko community

The history of KwaMsiza began in the ZAR-Ndzundza War of 1882 also known as the Mabhoko war when a commando of some 2000 Boers attacked Ndebele capital Namashaxelo. The Ndzundza were expropriated of their ancestral lands in the Middelburg-Grobblersdal district because of this war, their king, Nyabela, was eventually banished to the Hartbeesfontein estate, just north of Pretoria (Naude, 2007). He was accompanied by members of his family and a retinue of followers, including the Msiza, who had historically served as the king's shield-bearers. After Nyabele's death in 1903, his family moved away, leaving behind one of their daughters, Nomatombeni Dina Mahlangu, who had married Kgalabi Msiza in the meantime.

The family stayed at Wonderboom until they were forced to move to what is known today as KwaMsiza in 1953 which is in Kilpgat, under the authority of Mr Speelman Buhlakani Msiza (Chief). The present village was founded, and life goes on as usual. Mabhoko Ndebele community is a special place as the people still retain and follows its traditional way of life through Ndebele in general, i.e., traditional rituals, paintings, beadwork, and culture (Van Vuuren,2011; 2015).

3.8.3 The history of the AmaNdebele

A branch of the popular Nguni group of languages is the South African AmaNdebele. “They were originally part of the migration of Bantu cultural groups from Central and East Africa into southernmost Africa around 300400 AD” (Bell, 2000: 1). This original group from where the AmaNdebele came later became known as the Nguni group of languages. The Nguni language group is composed mainly of four groups, in no specific order, listed as follows: Ndebele, Swati, Xhosa and Zulu (Mashiyane, 2006). The far more common and most influential feature of this group is that in all the languages forming the group, the structure of their languages shows a remarkable similarity in both form and sound. They also share an intelligible bond that is very deep (Mashiyane, 2006).

The large Nguni party disassembled into smaller groups during the great Southward migration of the African people in groups from the Great Central African lakes in no prearranged phenomenon. Later, these smaller communities invaded and settled in different corners of present-day South Africa (Powell, 1995). The small groups formed a speech variety that was very distinct from the main group and from each other after a long alienation from the main group. Later, the languages of the small groups were so different from each other that they each gave new names for themselves.

Bell (2000) claimed that the first nation to break away controlled much of the eastern part of present-day South Africa and ended up calling itself the people of Swati and occupied the territory now known as Swaziland and other strips of land on the South African side and the Mozambican frontier outside the Swaziland border. In the southeastern part of present-day South Africa, the second party migrated and settled and ended up calling itself the Zulu people and controlling the whole region known today as Kwazulu-Natal.

The third group went south and settled at the southernmost point of the present South Arica and later named itself the people of Xhosa and even moved further down and occupied the Cape, especially the Eastern Cape. There is a fourth group, according to historical records, which migrated westward when the Swati moved eastward and occupied the region of what was later known as the Western Transvaal and later called itself the people of Ndebele (Mashiyane, 2006). Consequently, as some books erroneously claim, the AmaNdebele came from where all the other Nguni people came from, not from Zululand.

Kruger (1983) is of the opinion that among the first to break away from the main group was the AmaNdebele group. He reports that in the Western Transvaal, about 1500, the AmaNdebele were sighted. He describes, in his own words:

“According to historical data, the AmaNdebele must have been some of the earliest immigrants into the Transvaal and came here most probably before 1500. This makes the Transvaal Ndebele in all like hood the earliest Nguni immigrants into the TransvaaL It is, however, not clear at what stage and where the branching off from the main Nguni group took place.” (Kruger, 1983: 33). The AmaNdebele have secured for themselves a special and rich culture after having occupied this region generation after generation. Beadwork and mural art is among the most popular in their artistic traditions (Van Vuuren, 2015). They have managed to hold on to their tradition even after they invasion by the migration of Dutch farmers into their territory, known as the Boers. From the early1830s, the Boer farmers who had been migrating into the highveld in the Steelport River Basin area in growing numbers started to encroach on the areas occupied by the AmaNdebele.

Having developed into quite a powerful force the AmaNdebele was able to resist the Boer’s armies of the Zuid Afrikaanse Republick (ZAR) in 1849 and again in 1863 and the powerful Swazi army in 1864. Occupying some of the richest farmland in South Africa, the AmaNdebele prospered until the end of the 1870s. By the next decade, although they numbered scarcely more than a total of 10,000, this group was considered one of the most powerful ethnic groupings in the northern half of South Africa. Boer attempts to subdue the AmaNdebele stronghold on the area failed, even after several attempts (Mahlangu, 2016).

Mahlangu (2016) contended that after eight months of war, however, during which AmaNdebele crops were destroyed and their cattle confiscated, the AmaNdebele were eventually hungry for submission. King Nyabela who was a leader of the AmaNdebele finally surrendered to the Boers in July 1883. Regardless of all that has happened to the AmaNdebele, their continued resilience bolstered by their strong feelings of identity and deep traditionalism representing a symbolic process of empowerment that remains remarkable today. Although they originally formed part of the Nguni ethnic group, the AmaNdebele are currently identified as a unique group who speak a unique language and express their culture using mathematical artefacts.

Concluding remarks

The focus of this chapter was to critically argue out the importance of using African indigenous philosophies when conducting indigenous research. It argues that researchers need to use indigenous worldviews; Ubuntu Philosophy, indigenous research methodologies and indigenous research paradigms as guidelines for their research to put an end to the exploitation, harming and degrading of indigenous people and their knowledge. The use of indigenous philosophies to guide indigenous research means respecting cultural traditions and protocols that are essential when working with the indigenous community (Chilisa, 2012; Smith, 1999). Using indigenous philosophies in research often entails acknowledging indigenous knowledge as fundamental knowledge that, like Western knowledge, requires more investigation. The chapter further presented the study area and history of the AmaNdebele. The first part of this study focuses on the historical origin of the AmaNdebele mathematical artefacts. Its purpose is to trace when the AmaNdebele started using mathematical ideas and concepts in their artefacts, which form a great part of their culture and identity.

CHAPTER 4: HISTORICAL ORIGIN OF THE AMANDEBELE MATHEMATICAL ARTEFACTS

4.1 Introduction

The birthplace of both fundamental and advanced mathematics is considered to be Africa. Several archaeologists and historians have suggested that geometry, numerals, and algebra were used by ancient Africans in their everyday lives. It is assumed that after the continuous migration from Africa beginning in 30,000 B.C., mathematics began to spread across the world. There is proof of counting and numbering systems, games and puzzles, geometry, graphs, record-keeping, money, weights, and measures in African history, etc. (Gerdes, 1999).

The existence of the AmaNdebele mathematical artefacts dates back before the Mabhoko (mispronounced by whites as Mapoch) war, which took place in the 19th century. Before the 19th century, the AmaNdebele mathematical art was in its primary development until they were enslaved by the Boers and forced to work in farms. The lives of the early people of the Ndebele were intertwined with Beadwork embroidery and wall decorations from their early days of their civilization. Geometry among AmaNdebele is not a phenomenon borrowed from outside countries or introduced from them. It is a tradition that all African nationalities have been active in from the earliest days. The Ndebele people must have inherited it from all the African people's great grandparents (Mashiyane, 2006). Art has evolved and taken various forms and styles over the decades.

The history of the Ndebele people indicates that they were never exposed to schools during the early years of their development. The AmaNdebele, therefore, had not been schooled to be able to do sophisticated mathematical calculations. However, basic mathematical operations such as addition and subtraction were their daily exercise. Their ability to calculate was limited to counting their cattle and other household stock. Simple counting, that is, addition and subtraction was thus their daily bread (Levy, 1990).

This Chapter investigates the historical origin of the AmaNdebele mathematical artefacts. To achieve the objective of this study which was to investigate the historical origin of the AmaNdebele mathematical artefacts, this chapter focuses on the history

of AmaNdebele mathematical artefacts, paying attention to beadwork and mural art. This chapter is guided by the following question: Where do the AmaNdebele mathematical artefacts originate?

4.2 Methodology

4.2.1 Research design, approach and paradigm

First, the study used an investigative research design whereby the researcher worked towards gathering knowledge about the AmaNdebele and culture which she was not familiar with (Douglas, 1976). As it was mentioned before, (cf.1.6) the researcher has a background of AmaNdebele culture and tradition. She has further conducted a Master's degree on AmaNdebele ethnomathematics and needed more knowledge about the origin of mathematical ideas and concepts in the AmaNdebele artefacts, which were not covered prior by scholars hence these studies were conducted.

Second, for the entire study, an Indigenous-Informed Relational Approach was utilized. This approach allowed the researcher as a Ndebele to adhere to customary laws, properly communicate with participants, showing core values such as respect, inclusiveness, honesty, compassion, cooperation and humility (Wilson, 2008; Mitchell et al., 2019). In this study, an ethically correct and culturally appropriate indigenous method of acquiring and disseminating knowledge about the KwaMsiza Mabhoko community was required.

Third, to guide the entire study, an indigenous research paradigm was used by the researcher to envisage a relationship with participants where all contributions to the research process were valued. It was responsible for creating and developing long-term, respectful relationships because the quality of the results relied heavily on such relationships (Minkler & Wallerstein, 2003). At the same time, the researcher had a greater obligation to value the participants' worldviews of mathematical ideas and concepts in their artefacts and to express her own knowledge and experiences in a way that did not neglect or displace community knowledge (Moloi, 2016). Thus, it was critical for the researcher to present herself as a learner instead of a knower to the participants and community at large.

4.2.2 Target population

The target population for this chapter was ten AmaNdebele women in the KwaMsiza Mabhoko community. This population was selected though expert purposive sampling based on their knowledge of the history of the AmaNdebele and their art. Compared to other women, the selected population has years of experience in practising AmaNdebele artefacts and have in-depth knowledge about the origin of the artefacts (Campbell et al., 2020)

4.2.3 Sampling size and sampling procedure

Eight participants were sampled using an expert purposive sampling procedure (Etikan et al., 2016). One participant was able to select and identify the rest of the participants based on their knowledge and experience.

4.2.4 Data collection strategies

4.2.4.1 Tools

Focus group interviews were used as a data collection tool (see appendix 1) with the participants at KwaMsiza, within the Mabhoko community.

4.2.4.2 Methods

The focus group interviews were conducted in *Ebaleni,* in a round sitting*. Ebaleni* is an open space anywhere in the yard than the front of the main house (Bhuda, 2019). Before the data collection process took place, the researcher explained the procedure to the participants (see Figure 4.1) in IsiNdebele, which was the language of communication. The researcher gave the participants an opportunity to ask questions and to withdraw from participating in any case they felt uncomfortable. The questions that were asked by the researcher were open ended, allowing the researcher to probe further while at the same time observing the body language of participants while answering questions. A digital recorder, diary, video, and photo camera will be used to store data. Figure 4.2 shows the researcher engaging with participants *Ebaleni.*

Figure 4. 1: Researcher explaining the research process to the participants.

Figure 4. 2: The researcher interviewing participants in *Ebaleni*

4.2.5 Data analysis

The emerged data from the focus group interviews was manually analysed through a thematic analysis using the following protocols, as outlined by Braun & Clarke (2006): (1) This researcher read all the transcribed data from the in-depth interview and focus group interview thoroughly; (2) Once familiar with the data, she identified recurrent phrases and concepts that were considered important on which were highlighted and colour-coded in all the interviews; (3) concepts and phrases from the different data sets that were matched were then categorized into themes; (4) the researcher refined and defined the themes and potential subthemes within the data and similar themes emerged; and (5) the themes were reported as the results of the study.

4.2.6 Ethical considerations

The research proposal for this study was first presented to the Indigenous Knowledge System's ad hoc committee. It was then submitted to the Faculty of Natural and Agricultural Sciences Research Committee (FNASREC) for approval in November 2020 at the North-West University (NWU). An introductory letter was issued to the researcher by the Indigenous Knowledge System's center 28th October 2020 (see appendix 5) while waiting for the ethics application to be approved. Ethical clearance was granted to the researcher on 28 November 2020 (see appendix 6). Using both the introductory letter and ethics certificate, the researcher was able to get a permission letter to proceed with the study from the Ndzundza-Mabusa traditional leadership (see appendix 11).

Before the data collection, process took place, the researcher provided the participants with the letter from traditional leadership, introduced herself and the purpose of the research. Furthermore, participant consent forms (see appendix 7) were issued to the participants, followed by participant non-disclosure agreement (see appendix 8), Benefit sharing agreement (see appendix 9) and Material transfer agreement (see appendix 10) to sign. All the documents presented to participants were explained in detail before they signed. This was done in the presence of the community representatives to show transparency, trustworthiness, and reliability of the researcher. Participants were given a platform to make any inquires and withdraw from the process anytime they felt violated and uncomfortable.

The researcher also recognized the AmaNdebele's traditional laws about how a woman should be dressed and how she should talk to elderly people. In the KwaMsiza, Mabhoko community, the researcher wore long skirts and dresses with shoulders and hair always covered while conducting the study. This was a way of respect and followed advice that was given to her by elderly women in her family.

4.2.7 Risk and risk management

The participants were insisting on getting money as a token of appreciation from the researcher. The researcher did present to them documents as proof that she was a student who had passion on preserving the Ndebele culture. Even though proof was presented, the participants insisted that they needed money for participation in the study. The researcher had to negotiate, gave them money, and bought them food after the have participated. This was the only way participants can openly welcome the researcher and accept the study process in their territory.

4.3 Results

4.3.1 Introduction

This section of the study presents the themes that were found during data analysis which are as follows: artefacts as ethnic consciousness before the sixteenth century; existing of artefacts before the Mabhoko war; using of natural materials before the introduction of glass beads and modern painting. Themes that emerged is as follows: changing of styles and colours over periods.

4.4 Artefacts as ethnic consciousness before the sixteenth century

The findings of this study show that AmaNdebele mathematical artefacts started being expressed before the 16th century when the AmaNdebele moved to the Transvaal. Furthermore, according to participant 1, because there was no formal documentation during that period, most scholars believe that AmaNdebele mathematical art was born in the mid-19th century soon after the Mabhoko war which, it was not true. In her own words, she stated the following:

> *"AmaNdebele wathoma kade khulu ukugwala nokuphothela ngaphambi kwepi namaBhunu kodwana kokhe khenge kwatlolwa phasi begodu neenthombe zokuvezalokho azikho. Yeke, kungalelo banga abantu abanengi bazitjela bona*

sathoma lokhu ngemuva kwepi ngombana kunemitlolo etjhonjalo ekungeyamalanga la". The AmaNdebele started a long time ago with mural art and beadwork. This was long before they had a war with the Boers. However, due to no photographic records and writings, most people believe that this art came into existence after the war because of the recent writing that states so.

Participant 3 told the researcher that the AmaNdebele creativity is more than what meets the eye, rather it is spiritual, and it is the art that was established based on their beliefs. Therefore, the AmaNdebele did not start practising it on their free will, rather consulted with the supreme beings first then obtained permission and rules pertaining to the art. The results of the study state that AmaNdebele mathematical artefacts before and within the 16th century was in their development stage, expressed using natural objects obtained from the environment.

Beadwork in the 16th century was more dominant and practiced compared to mural art, hence most houses during that period were plain white or showing less geometric shapes. In most cases, royal houses had evidence of mural art with triangular shapes, which means the shapes had the potential to develop in the future. Therefore, due to lack of earlier documentation, the AmaNdebele only know such evidence and perhaps the earlier scholars/historians/settlers who visited AmaNdebele and mostly never recorded the proof of the existence of such designs.

However, participant 4 stated that, history is a mystery, even though many people have knowledge that mathematical artefacts, specifically beadwork started in the 16th that is not correct. According to oral history of AmaNdebele, culture expression even started earlier. In fact, according to the participant, cultural expression amongst the AmaNdebele started when the AmaNdebele came into existance. This, however, certainly represents, rather than relating to the actual origins of the craft, the central importance attached to beadwork and its roles within the community today. This further means that contemporary AmaNdebele women consider beadwork to be an ethnic category and as central to their self-definition.

Participant 4 further made an example that AmaNdebele cosmology can reveal the origins of the artefacts. Ndebele people believe that uZimu, a supreme God has

over the years given people direction and demands on how they should identity themselves. She stated that:

> *"UZimu nguye otjela abantu bonyana benzeni begodu ibanga yini, yeke, nguye asekelwe bezimu owathi AmaNdebele makaphothele negodu agwale ngendlela enza ngayo. Akusiyinto yokuzithomela".* God is the one who directs people and give them instructions. God supported by gods has instructed the AmaNdebele to do mathematical artefacts. This was not spontaneously started.

Based on the example made above by the participant, there might be a link and relationship between AmaNdebele beliefs and the origin of the mathematical artefacts. At this point, the current fragments of early Ndebele history are useful to explore, as they suggest that they provide details on potential developments in art.

4.5 Existence of mathematical artefacts before the Mabhoko war

The results of the study show that the war between the Ndzundza Ndebele and Boers, which happened in the 19th century, played a significant role in the development of the Ndebele mathematical artefacts and defending the identity. Developing the Ndebele mathematical artefacts was an attempt to reinforce a sense of group identity. At the beginning of the 19th century, the AmaNdebele faced so many difficulties and conflicts that let them to divide and continued dividing even after the Mabhoko war. Therefore, when they were working hard to regroup, their art gave them a strong sense of belonging and identity.

In the face of the advances of Boer settlers, under the leadership of King Nyabela, the AmaNdebele retreated to a place called Erholweni or the Mabhoko cave (see figure 4.4), where they constructed large impenetrable fortifications that became their fortress to protect their political autonomy. The violent encounter with the colonizing Boers and particularly the defeat at the Mabhoko caves, forms the basis of the notion that since the late 19th century, the AmaNdebele have had a vulnerable life.

In all interviews conducted, a thread that stressed how the precarious circumstances faced by the AmaNdebele after their early settlement in the Transvaal did not prevent

them from preserving their autonomy was widely recounted. Comment have been made on the controversial relationship between the Ndebele Ndzundza and the Boers that saw the AmaNdebele fleeing to the caves of the Mabhoko.

This was best expressed by participant 6 who stated the following:

> *"Ipi esabanayo namaBhunu ngiyo eyasenza bona siphaphame simaNdebele sikakarela nobuthina bethu. Ngebanga lepileya, sabumbana simaNdebele sabayinyanda yinye begodu savuselela namasiko kanye nobukghwari bethu, into ekade besinayo kusukela ekuthomeni kodwana yathikanyezwa kuphadlhalala kwabantu bekhathu".* The war we have encountered with the Boers made us strong, unite and reclaim our culture identity, something that was there before but got disturbed by the scattering of our people.

Similarly, another interviewee, an elderly woman who was comfortable disclosing voluntarily that her recollections of the past of the experience with Boer-Ndebele were based on what she learnt from the older generation:

> *"Loke iNdebele liyazikhakhazisa ngoburholi buka Nyabele ngombana ngebanga lakhe, AmaNdebele wakghona ukuphepha begodu wabhaqela amaBhunu. Kungebangalika Nyabela bona AmaNdebele wakghona ukuzibuthelela, waragela phambili ngamasiko nobukghwari asele akhulile wandlondlobala namhlanjesi. Amasiko wethu nobuNdebelele bethu baphephiswa nguNyabela. Namhlanjesi, AmaNdebele aziwa ngomgwalo nokuphothela kungebanga likanyabela owalwela isikhethu".* All the AmaNdebele know about the leadership of Nyabele. It is because of his that the AmaNdebele reunited and continued with the cultural expression that is known today. Nyabela protected our culture and identity and presently, the AmaNdebele are known for their mathematical beadwork and mural art because Nyabela made certain that we never lose our identity.

In ways that deeply scaffolded the history of Ndebele-encounter Boer's with King Nyabela and the heroism narrative as a long-standing tradition, the above excerpts were variably echoed. A thorough study of the narratives on the history of the encounter between Ndebele and Boer illustrates the confluence of precocity and heroism resulting from the experience of colonial conquest, thereby putting the leader in the history of the Ndebele in a crucial position.

This is part of the narrative that primarily establishes the AmaNdebele's identity of authority, which puts the King (Figure 4.3) at the core of how past relationships with colonial experiences are remembered and how he has contributed to what is regarded as mathematical artefacts from AmaNdebele.

King Nyabela's memorialization as a great man in AmaNdebele is reflected in the strand of the history of marginalization and heroism in ways that required the analysis to prove how mathematical artefacts maintain AmaNdebele's identity in the face of confrontation with the Boers is explained in chapter 6. Much of the narratives gathered from older generations cast their feelings in ways that pointed to passionate appeals to preserve memories of the AmaNdebele's struggling to preserve and claim their belonging against the Boers. The act of fighting to resist the dominance of the Boers ran deeply as a symbol of heroism that preserved the identity of AmaNdebele, reflected in common statements such as "We are one group of people who fought with the Boers, we fought to maintain our freedom and to show them that we do not want to be separated, we are a nation of Ndebele".

Figure 4. 3: King Nyabela's statue next to Mabhoko caves

Figure 4. 4: The Mabhoko caves where AmaNdebele were hidden during the war

A significant feature of Ndebele mural painting supports the AmaNdebele in the time after the Mabhoko war. Although the practice of wall painting emerged drastically in the 1940s but there was prior than that, the sense of mural art has often been closely linked to the ethnic consciousness that originally developed before the Mabhoko War, and which seems to have filtered into the twenty-first century over the following decades. The introduction of glass beads and paint enhanced the art of the AmaNdebele, and it is when geometric patterns started being noticed by many. The geometric designs in mural art over time have been enhanced and developed.

According to the findings of this study, the development of the AmaNdebele artefacts has undergone three periods, dating from 16th century to present, showing how sophisticated they have become over the years. The three periods are discussed in the next subtheme.

4.5.1 Changing of styles and colours over periods.

An analysis of styles of Ndebele colours and attires over the ages clearly demonstrates that over centuries the artefacts have evolved. For the purpose of this research, the production and modification of the artefacts will be graded according to periods that are classical, intermediate, and the period of modernity. Firstly, results from beaded attires are presented, followed by results from mural art.

4.5.1.1 Changing of styles and colours in beadwork

The classical period

The classical period refers to the most remote period known where the people of the AmaNdebele began to develop themselves as a community. It is a time so far back in history that when this period was, none of the present generation can tell precisely. Only provisional estimates of the year can be made. This period was earlier than the year 1600. It is estimated that this period stretches up to the early 1930's.

Life was marked by unrest, wars, and simple conventional life during this period. The Western love of dress was not yet common, and the traditional people of AmaNdebele were still anchored to the dress of their forefathers. Beadwork samples that survived the hard times and brought it into the current era illustrate a simple and non-sophisticated style as seen in figure 4.5. That implies that the art of beadwork was still in its infancy among the AmaNdebele. There was still a long road ahead before the new expectations could be reached.

Umdereso (headband decorated with small coins)

Imilingakobe (Free running beads)

Isirholwani (circular neck hoop)

Isibhukwana (a small knop-kerrie used for dancing)

Unokhethwako (beaded blanket)

Figure 4. 5: A Ndebele woman wearing a white beaded outfit in a classical period

From the classical period, the AmaNdebele emerged with white being their favorite colour for both mural art and beadwork. This was possibly a reflection of large stretches of unoccupied land and the lack of present city or city building conglomerations. More than eighty percent of all this period's beadwork ornaments were made of white beads. This does not mean that, during this time, other colours did not play a role at all.

Sporadic patches were also discovered consisting of colours other than white but played a much lesser role. It is important to note that the pure white colour has been preserved to date by some Ndebele female dress called *amayirhani*. Therefore, because of the superiority of the white colour, this period can be rightfully referred to as "the period of white beads" in beadwork.

The intermediate period

The intermediate period began between the early 1930s and the late 1930s. The 50's. Colours used during this period in beadwork are a testimony of the fact that this was a different time indeed, according to participants. The Ndebele environment has changed dramatically. Empty tracks of land had towns mushrooming inside them with vibrant houses. It was just about to shift the traditional view of the world through white colour. With trains going up and down, railways were being developed across the country.

Tarred roads with cars going up and down were also a novelty. Within the era of the World War, the greater portion of this period dropped. The regular vision was composed of huge, armored tanks pulling cannons. The Ndebele artist was deeply influenced by this modern vision of the world. The view that the artist from Ndebele is still affected by what she sees or carries around her. This was going to be seen soon in works of art, like beadwork and murals. Suddenly, the range of favored colours shifted from mainly white to a mixture of various colours. In Ndebele beadwork, forms and figures representing geometric figures.

White beads used mainly as background characterized this time. What characterized this period, however, is the development of large shapes and figures of all kinds that began to surface and became a force to be counted on. The artist used colours which contrasted well with white to ensure that these shapes caught the eye (see Figure 4.6). Colours such as royal blue, sky blue, green, red, and black came to play a very

important role during this time. Thus, because of its colourings, this time appealed a lot to the sense of sight. The classical period can be compared to dawn and the immediate period to the period after sunrise to midday by contrasting this period with the period before it.

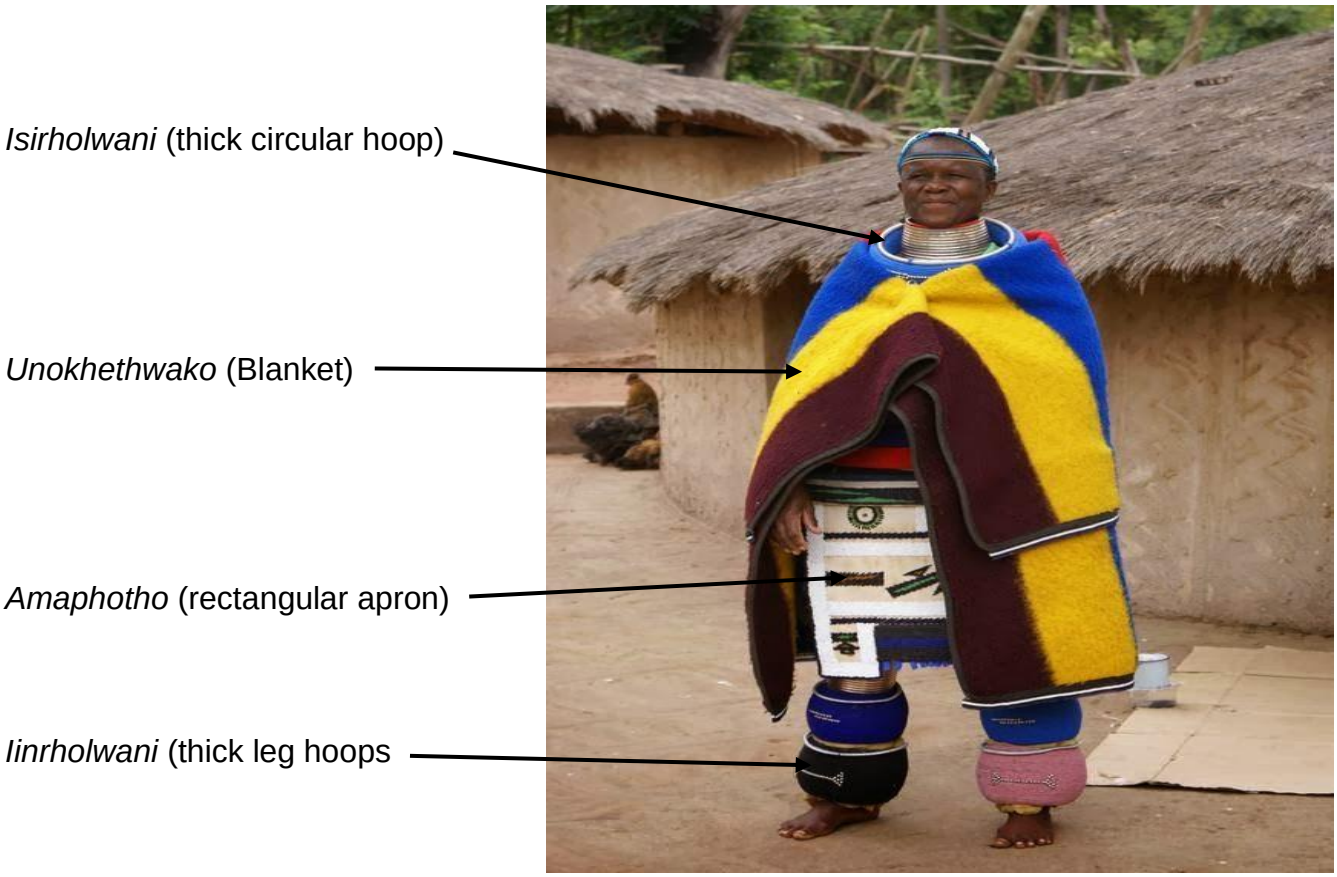


Figure 4. 6: A Ndebele woman wearing colourful beaded attire in the intermediate period

The modern period

The late 1950s saw the rapid entrance of the modem era until the early 1960s. In the early 1950s, the wave of the modem period began and is still on as we speak. There was simply no doubt that this was a new era of beadwork, as the rapid shift in colours used in beads made this so clear. The overwhelmingly white backdrop seemed to have passed over a hill and black beads were on the rise. All the superstitions related to the colour of black and black beads were dead and buried. Black beads got a massive embrace from the bead staff of Ndebele as well as the entire youth of the time.

The big shift in the colours of beadwork must have taken the older generation by surprise. Modern beadwork is mainly made of black beads. This is the same room that

white beads previously filled. For all the background work, black beads are used. For any piece of beadwork, it has become trendy to have a larger percentage of black beads (see Figure 4.7). The link between black beads and white beads was maintained during this time. A clear statement is often made by contrasting black beads with white beads and is always a favourite of bead staff. Other favourite Ndebele colours are also used, but more as supporting colours, such as blue, green, purple, and so on. Their appearance is considerably less comparatively speaking for this reason.

The biggest contrast between the intermediate period with the present period is that the intermediate period appears to be 'Light' and 'grey' from the modern era. These two, however, should not. The elegance of any piece of beadwork may be misunderstood as sacrificing. The moment when the elegance of all articles is untouched by the transition in colour.

Figure 4. 7: AmaNdebele women wearing black beaded attires in a modern period

4.5.1.2 Changing of styles and colours in mural art

The results from this study show that the Ndebele architecture has evolved over the decades. It also shows that the colours used for paint and the styles have also evolved. This section provides the results of three stages the Ndebele architecture, mural art and colours have undergone.

The classical period

Ndebele houses were built in the form of a thatched dome and were set in a circle about a central cattle byre. This was in the 1600s to the early 1800s. The walls of the Ndebele houses were decorated with black and white patterns. Unlike in beaded attires, at this period, both black and white colours were dominant in the Ndebele mural art. According to participant 3, the possible reason is that AmaNdebele women needed their geometric shapes to be visible, thus two colours were used. Participant 6 supported the statement asserting that both colours were used with the instruction of the ancestors because nothing was done by AmaNdebele without consulting with the spiritual world.

In this period, the AmaNdebele women only constructed one pattern, which is the triangle (Figure 4.8). Evidence of symmetrical geometry were visible in the patterns constructed by the women. The AmaNdebele women used no instruments for their paintings, just free hand drawing and years of experience.

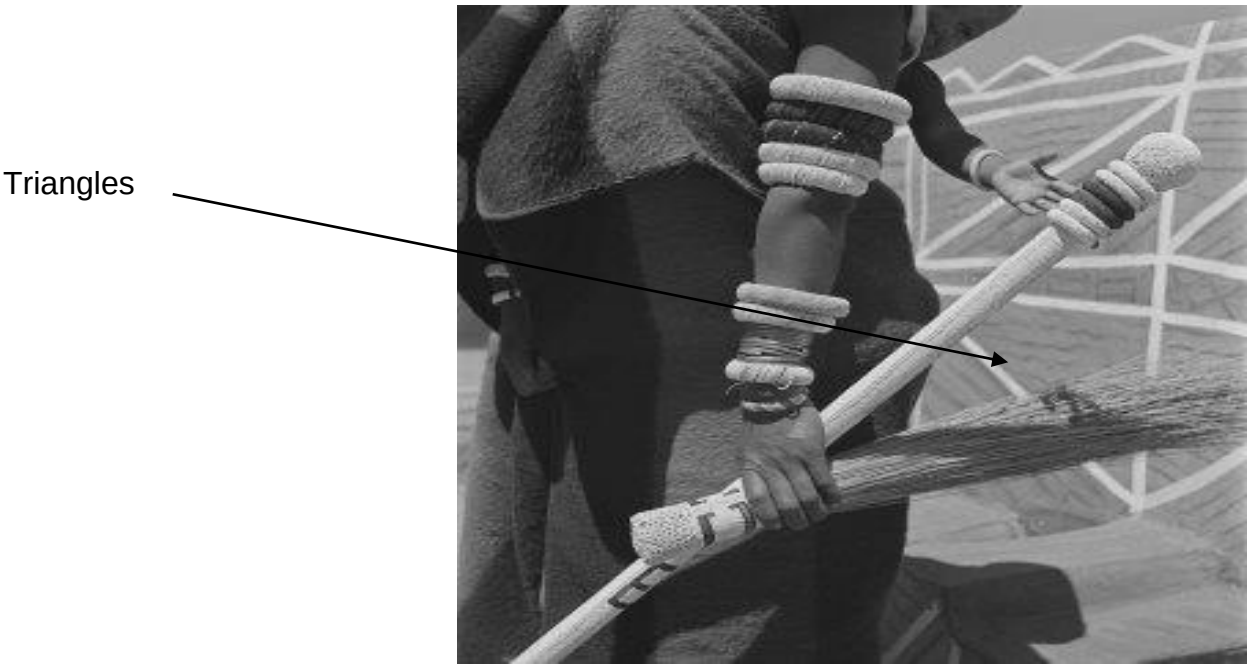


Figure 4. 8: Ndebele house patterns in the classical period

The intermediate period

The intermediate period began in the mid-1880s, soon after the Mabhoko war. In the shape of a central drum, some six to eight meters in diameter, surmounted by a conical thatched roof, AmaNdebele began to build their dwellings. A narrow-enclosed verandah about 150cm wide was facing the front of the unit, which extended on the floor plan from about 4 o'clock to 8 o'clock. This was used for young kids as a storage area as well as a sleeping room. The parents used the central circular space as a sleeping area, the left-hand side being considered the woman's side, the man's right side. In this period, AmaNdebele women started using modern painting and more colour was visible in their mural art. The AmaNdebele women started introducing new shapes in their art which included zigzags and diamonds (Figure 4.9). These patterns were used until the early 1950s. According to participant 1, this was a difficult period for AmaNdebele, and the mural art was used as a way of communication amongst the people.

In her own words, participant 1 stated that:

> "*Umgwalo wesikhethu ngemvakwepi yamaBhunu wakhula begodu mandlondlobala. Lokhu kwenzlwa bona AmaNdebele akghone ukwabelana umlayezo. Ekuthomeni, bekuyindlela yokuziveza bonyana sibobani, kungasiwo umrhabiso kwaphela"* Our traditional mural art developed drastically after the war, and it was then used as a way of communication. However, before the war, the mural art was only used to signify our identity and its purpose was not just for decoration.

From the above response, it is clear that participants have knowledge of early Ndebele patterns used and how they have developed after the Mabhoko war. Based on the results of the study, AmaNdebele women have been using geometric shapes before their encounter with Europeans, which the shapes have been added in their art with passing of time.

Figure 4. 9: Ndebele circular dwellings and geometric shapes during the intermediate period

Classical period

In this period, most of the Ndebele settlements had shifted to a linear pattern (Figure 4.8) by the late 1950s. In the left-and-right hierarchy, the homes of individual family members were still set out according to their position, but the homestead now followed the contour lines of the land, an arrangement that allowed better use of their agricultural resources. While still central, the cattle byre was now in a square shape, and was situated opposite the home of the family's senior member. This was the trend adopted at their home in Hartbeesfontein by the Msiza, which they repeated when they were moved in 1953 to KwaMsiza.

However, in time, the village started to grow along new and revolutionary lines, somewhat different from those previously followed by the Ndebele. In a shallow V-shape, the initial settlement at KwaMsiza was laid out, with the Msiza family taking up their homes along one arm, while the Bhuda and Skosana families settled along the opposite arm. The settlement was facing north and some 200 m to its north, situated approximately parallel to the main road. Behind their houses, downhill and towards the river, was their agricultural land.

In this period, shapes that are more geometric are visible in the Ndebele mural art form. Shapes such as the rectangular, circle, chevrons shown in figure 4.10. Modern

Ndebele mural art also shows detailed horizontal and vertical lines, compared to previous periods.

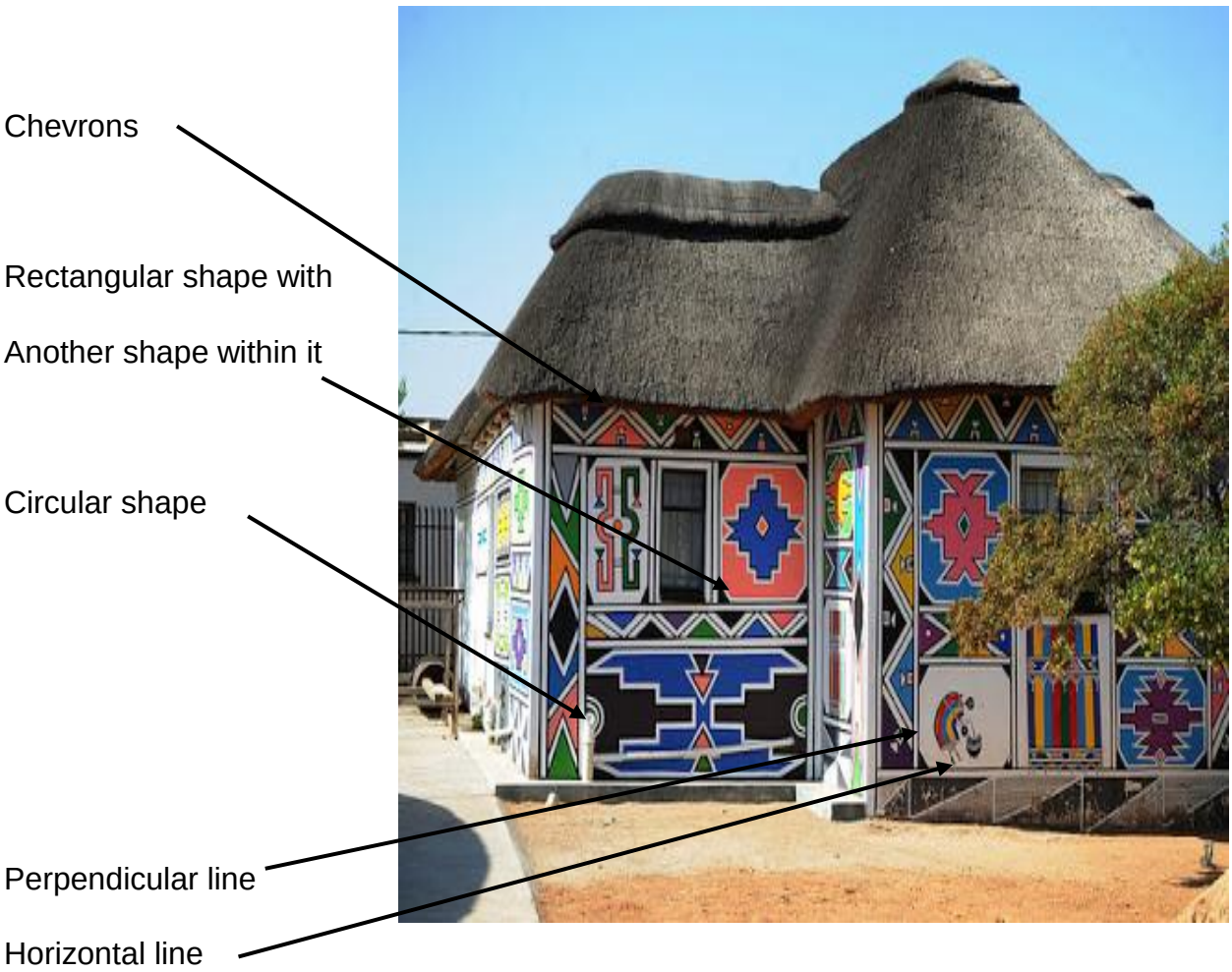


Figure 4. 10: Linear Ndebele dwellings and geometric shapes found in classical period.

1.4.1.3 The two different Ndebele Mural styles

One participant said during the focus group interview that the two Ndebele mural art styles should be identified and explained to people who claim that modernization inspired Ndebele mural art and that it did not exist before the meeting with the Boers. More participants claimed that the Ndebele mural art that depicts modern things is solely for the purposes of creativity and fashion. The artworks are of no cultural value. Instead, they highlight AmaNdebele women's abilities and the extent to which they can merge their tradition into modern society. Participant 3 mentioned that there is a painting known as *isitjhefana* and another known as *isirayithoni*, both of which are prominent Ndebele styles. Isitjhefana is a traditional Ndebele painting with important geometric shapes, as seen in Figure 4.11, but *isiraythoni* is a modern Ndebele painting

with current innovations and displays modern objects such as bulbs, as shown in Figure 4.12. The myths surrounding Ndebele mural painting must be dispelled, according to participants, because individuals who do not understand the traditions make incorrect assumptions, which disrespect the entire Ndebele society.

Figure 4. 11: *Isitjhefana* Ndebele mural design

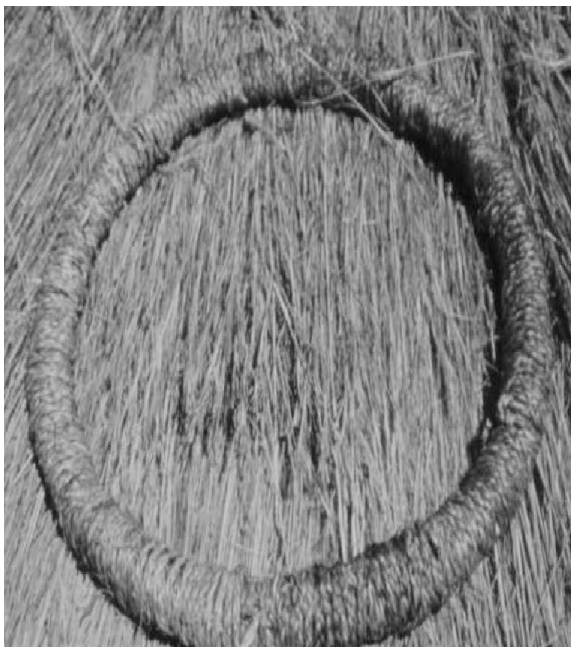
Picture 1: Ndebele painting refecting modern objects Picture 2: Ndebele paintings reaflecting South African national flag

Figure 4. 12: Isirayithoni Ndebele mural design

4.6 Using of natural materials before the introduction of glass beads and modern painting

The Ndebele produced beads from natural materials before the advent of glass beads which were introduced by Portuguese. Natural materials such as the ostrich eggshell, which was chipped and ground to the approximate size, bored and polished before being strung were used. Metal beads have also been developed because they are well polished and durable. They were rare and highly regarded, as beads took a long time to produce. Some decorations included animal teeth and horns. For making necklaces, bracelets, belts and anklets, bone, ivory, sandalwood slats, tambotie and other woods, seeds, and plant roots, as well as shells, were strung on fibre and animal sinews. For decoration, tufts of animal hair, bits of animal skin, feathers and small horns were added.

In addition to the above, grass ornaments, newly woven each season, were also worn. These original materials which were used as ornamentation did not disappear with the introduction of glass beads but were used together with beads. For instance, the Ndebele hoops are made from Grass (picture A) then beads are sewn on top. The bead worker determines the size of the hoop, using grass, then does mental calculations using beads to create a desired hoop, as shown in Picture B, Figure 4.13 by the researcher. For mural art, colours were sourced from the following: red colour sourced from red ochre; white colour from white clay; black colour from charcoal and cow dung; yellow colour from yellow ochre; green colour from leaves and other colours are produced from mixing different colours.



Picture A: Ndebele hoop in its creation stage

Picture B: Researcher wearing completed Ndebele hoops in the neck

Figure 4. 13: Ndebele hoops at an initial construction and final stages

The utilization of natural resources by AmaNdebele shows the advancement of the Ndebele art before the introduction of modern paint and glass beads. Therefore, it can be deduced that Ndebele art dates before the 19th century. Participant 6 supports this statement by mentioning the following:

> *"Isikhethu sidala, thina simaNdebele kade sathoma ukugwala nokuphothela. Akusingiyo into yamalanga la, njengombana abanye batjho*." Our traditions are old. We have been experessig our culture through beadwork and mural art since time immemorial. Therefore, this is not modern art, as other people believe.

4.7 Discussion

4.7.1 Introduction

This study has investigated the historical origin of the AmaNdebele mathematical artefacts. The changing of styles and colours in AmaNdebele's mathematical attires were also discussed in this chapter. This discussion emerged from the findings of this chapter.

4.7.1.1 AmaNdebele mathematical art existed before the Mabhoko war

The AmaNdebele mathematical artefacts existed before the 16th century. Therefore, during the Mabhoko war, the AmaNdebele mathematical artefacts were used as cultural identity and continued to develop after the war. The AmaNdebele also used natural resources as beads and paint before the arrival of Europeans in their settlements, proving that they have long been practising cultural expression using beads. Powell (1995) reports that if it were to be believed that the AmaNdebele understanding of beads dates back only to the first arrival of the first Europeans in Mpumalanga, formerly known as the Transvaal, it would be a gross oversight.

It would seem more reasonable and fairly accurate to conclude that this is an art that was started by AmaNdebele ancestors far earlier than is suggested in most books on this subject, judging from the sophisticated patterns developed by the AmaNdebele bead handlers, and judging from the advanced manner in which beadwork is done by the AmaNdebele at the moment.

The possibility is that it began from modest beginnings and steadily gained momentum to achieve the current heights it has achieved. Some authors, such as Davison argued that:

> Historical evidence suggests that Ndebele beadwork developed rapidly after the Mabhoko War of 1882, when white settlers in South Africa defeated the Ndebele. They uprooted and relocated the Ndebele to different parts of Southern Africa and yet they never lost their identity. (Davison, 1985: 19).

The arguments made by Powell (1995) and Davison (1985) are linked to the Afrocentricity theory by Asante (1980) used to guide this study. The existence of AmaNdebele mathematical artefacts started earlier before they had an encounter with the Boers. Non-indigenous scholars have made claims regarding its origin due to a lack of modern record, concluding that Eurocentric creativity affected such a cultural representation. To rectify such clams and allow AmaNdebele to interpret their own cultural experiences and genesis of their own knowledge, oral history from AmaNdebele descendants was crucial for this research.

Selin (2008) published a review in Mathematics in Africa South of the Sahara, noting that most mathematics history books devote just a few pages to Africa during the Middle Ages, and even then, only to Ancient Egypt and northern Africa. They usually

disregard the presence of African mathematics. They also often dispute that mathematics in Egypt is African.

In this prevailing Eurocentric view of the history of mathematics in Africa, the publication of Zaslavsky's (1973), titled Africa Counts: Number and Pattern in African Culture, questioned those views. When a broad mathematics term is used, including counting, finding, measuring, designing, playing, clarifying, classifying, sorting, etc. Mathematics is simply a pan-cultural phenomenon that manifests itself in several ways. There is proof of counting and numeration systems, games and puzzles, geometry, graphs, record keeping, money, weights, and measurements, etc., in African history. Mathematics in Africa should not be treated in isolation from the growth of culture either (Selin, 2008).

Eglash (1999) who wrote about Fractals in African cultures stated that, the fractal settlements in Southern African cultures were our thread to Europeans and made them question the knowledge Africans had of mathematics. In his words, he wrote, “the fractal tradition was a threat. But kept in what colonialists thought of as its natural role, it could make fractal settlements appear to benefit the colonialist”. He further stated that in 1871, Carl Mauch, a German geologist, claimed to have found the ruins of Great Zimbabwe.

Stunned by the facts of mathematics and the vast precision of stone cutting, he suggested that the buildings were not of African art but were instead attributable to the visit of the Queen of Sheba to Solomon. His fear was to acknowledge advanced mathematical knowledge of African people and their early civilization. Stones that had been painstakingly trimmed were used by the creators of the great Zimbabwe to fit comfortably together and lay them in even courses, some of the time placing them in decorative designs, such as zigzags or chevrons, a V-shaped style, demonstrating sophisticated computational knowledge (Ibid, 1999)

Moreover, similar studies that were conducted by Gerdes (1995) on Swazi grass mats revealed that whilst collecting, collating, and analysing the different properties of the Swazi grass mats, it became evident that although geometric patterns existed on a large number of grass mats, the Msithini Group in particular displayed the “hidden moments of geometrical thinking” referred to by Gerdes (1995). Ascher (1994), a fellow Ethnomathematician, agrees with his theoretical and empirical claims; she

believes that a better grasp of the ideas behind the artefacts, as they are culturally ingrained, is required in order to recognize their mathematical features.

The AmaNdebele clung to their art and never allowed it to die out even after 1885 when the AmaNdebele was defeated, humiliated and downtrodden and their reputation dragged into the mud of shame by the Boers at a place called *kwaNomtjherhelo*, renamed *Roosnekaal* by the Boers. It is almost unimaginable that they rose from the dust after the AmaNdebele reached the verge of near-total obliteration and moved mathematical artefacts the up to the heights it is today. This is how the horrors of South African history have survived the Ndebele beadwork and flatly refused to die (Mashiyane, 2006).

Beadwork and mural art are other original, important things that the AmaNdebele have hang onto, in addition to their language. In 1885, at *kwaNomtjherhelo*, the AmaNdebele mathematical objects were almost demolished by the Boers. Their language and their art of beads and house painting were the only three items that kept them together as a society and perhaps continued to tell the world their story while they themselves were impoverished and lacking the understanding of how they could not do it on their own.

Powell (1995) disproves the postulation that the Ndebele handling of beads could date as far as the settlement of the first Europeans in the Transvaal. He writes in his own words:

> The plain fact is that the actual beadwork produced by AmaNdebele women in the later nineteenth century is of such a quality and degree of elaboration that it would suggest a long and developed tradition. Besides, we have evidence of a widespread trade in manufactured beads within the southern African subcontinent that predates by several centuries the first known Ndebele pieces. (Powell, 1995: 108).

The AmaNdebele depended solely on natural matter until glass beads were introduced to the AmaNdebele. Ostrich eggshells were one of their favorite materials. These were cut into small parts about the size of a 10-cent coin. They would then be well washed and, if appropriate, polished, or painted. They will then, depending on how the artist likes them, be cut into desired sizes and shapes. At the middle of each one of them, a hole will then be pierced open. A thread

consisting of some kind of grass, or a thin lace cut from skin will then be pulled to form a necklace from each of them. Also used were capsules from dried seeds. They were only threaded together to form necklaces, as these were almost ready to be used.

Among the Xhosa people, Costello (1999) researched beadwork and found that the Nguni people often made use of metal to make beads. These were especially favoured because they were durable, and one could polish them to shine. The AmaNdebele use the smallest of the coins to this day, polish them and loop them on a thread to create a beautiful "*umdereso*" worn on the forehead on special occasions such as weddings, often by elderly women. Animal teeth, animal nails, horns, ivory, carved wood, seeds, and roots of plants were other materials used.

Ndebele houses were painted using natural resources such as white clay, charcoal, and cow dung before they were introduced to modern paint, proving pre-existence of Ndebele technologies before modernization. Ringuede (2016) conducted similar studies on West African textiles and her findings state that Africans used natural colours for their textiles. She addressed the Kofar Mata dye pit that has operated since 1498 in Nigeria and still operates, although currently just over half of the 100 pits are used. Pits are handed down and tightly handled from generation to generation, while the knowledge and secrets of African textile indigo dyeing are tightly controlled. In general, fabrics are painted in solutions made from mixtures of water, ash, and dried indigo twigs in holes below the ground. For precise depths of colour to be achieved, regular dips of the cloth are needed. She further claimed that in the Fouta-Djallon, a high plateau region in Guinea, known as the 'Water Tower' of West Africa, the indigo wrapper, a two-yard rectangular piece of clothing from the typical feminine wardrobe, was made for centuries before colonization. This is evidence of the long-lasting civilization of Guinea before France colonized it (Ringuede, 2016).

Ndebele mural art has spiritual and cultural significance, which serves as ethnic identity. AmaNdebele believes that the spiritual world has influenced their geometric artefacts, which serve as cultural identity. Therefore, the claims made by Lalioti et al (2001) which stated, “Surprisingly, the Ndebele art form is not connected with the mystical and does not possess any sacred significance for the AmaNdebele

themselves. However, for the women, wall painting is important as a celebration of the domestic environment" should be considered incorrect, as she provides no evidence of conducting filed work and having reliable sources. In order to correct misinterpretation and information that is exchanged by scholars who do not use an indigenous lens when conducting research on African knowledge, it is therefore, necessary for African scholars to conduct research on their own indigenous knowledge.

Concluding remarks

The AmaNdebele mathematical artefacts existed, before the Mabhoko war which happened in the 19th century. The mathematical artefacts stretch even before the 16th century proving the early civilization of the AmaNdebele. Over the decades, the AmaNdebele artefacts have developed under the authority of God and ancestors according to AmaNdebele worldviews and beliefs. Furthermore, as per the beliefs of the AmaNdebele, using artefacts for culture expression was an instruction from higher beings who dwell in the spiritual world. Therefore, the colonizers did not play any vital role in the existing of AmaNdebele mathematical artefacts as they existed before they met the Ndebele nation. Literature that was reviewed in this chapter reveals early mathematical existence within African societies and argues that Africa has mathematical history that existed before colonization, which should be acknowledged and preserved. The cosmic genesis of the AmaNdebele mathematical artefacts will be discussed in the next chapter.

CHAPTER 5: THE COSMIC GENESIS OF THE AMANDEBELE MATHEMATICAL ARTEFACTS

5.1 Introduction

African indigenous cosmology could be portrayed as a way Africans see, conceive, and contemplate their universe. “It is the lens through which they see reality, which influences their value systems and attitudinal directions; it is the African's quest for the significance of life, and an unconscious but natural tendency to land at a binding together base that comprises a frame of meaning frequently viewed as terminus a *quo* (root), and as terminus ad *quem* (end). This cosmology is the underlining thought interface that holds together the African value system, philosophy of life, social direct, morality, folklores, myths, rites, arts, rituals, norms, rules, ideas, cognitive mappings and theologies” (Madu, 2004: 533).

Viriri and Mungwini (2010) added that for Africans, cosmology alludes to a people's worldview subsequently one can talk about the Shona cosmology, the Dogon cosmology, the Basotho cosmology, and the AmaNdebele cosmology. The idea of African worldview must be comprehended in a general sense and in a limited sense because what we call the African worldview is not one shared by all Africans in its totality yet rather some characteristic features of the common elements among African worldviews (Holbrook, 2007).

The AmaNdebele believe in the supreme God, *Zimu* "who rages in the thunderstorm and when angry brings drought" (Kuper, 1978:111). He is distinguished from the ancestral gods or abezimu. Traditional rituals are done in order to be at peace with uZimu and abezimu. According to the belief systems of the AmaNdebele, the cultural practices are influenced by the relationship people have with God and their ancestors. AmaNdebele do not make anything part of their culture unless there is a direct instruction from the supreme beings who are God and ancestors. The objective of this chapter was to investigate the cosmic genesis of the AmaNdebele mathematical artefacts. The work was guided by the following question: What is the cosmic genesis of the mathematical artefacts?

5.2 Methodology

5.2.1 Research design

The researcher used an investigative research design to investigate the cosmic genesis of AmaNdebele mathematical artefacts (Douglas, 1976). AmaNdebele mathematical artefacts are not only used as cultural expression and identity, but they also have cosmic genesis which this chapter will investigate.

5.2.2 Target population

The target population for this chapter consisted of six women who are custodians of AmaNdebele mathematical artefacts. They were selected based on their knowledge of the history of the Ndebele mathematical artefacts.

5.2.3 Sampling size and sampling procedure

The sampling size consisted of six participants who were selected using expert purposive sampling procedure because of their high degree knowledge of Ndebele cosmology and mathematical artefacts.

5.2.4 Data collection strategies

5.3.4.1 Tools

The researcher collected data using semi-structured in-depth interviews (see appendix 2). The researcher did not follow a formalized list of questions but instead asked open-ended questions to allow participants to express their views and expand their answers during the interviews. Semi-structured interviews are be used by researchers to gather new, exploratory data about a research subject, triangulate other data sources such as camera, voice recorder and notebook to verify findings through member checking (respondent feedback about research results).

5.3.4.2 Methods

One on one interviews were conducted in the environment of the participants. Each interview took 1 hour. Body language and facial expressions were observed during the interview. Information was captured using a recorder and noted were taken using a dairy, with a consent of the participants.

5.2.5 Data analysis

Data was analysed using a thematic analysis by following steps: the researcher familiarizing herself with the data, creating initial codes, collating codes with supporting data, reviewing, and revising themes, and writing the narrative.

5.3 Results

5.3.1 Introduction

Themes that were identifies for this chapter were as follows: Spirituality of the AmaNdebele; cultural beliefs of AmaNdebele; symbolic meaning of geometric shapes.

5.3.2 Cultural beliefs of the AmaNdebele

In AmaNdebele religious life, God is acknowledged and so are ancestors/ ancestral gods. People usually do offerings and sacrifices in exchange of good health, happiness, and protection of the ancestors. God and ancestral gods are believed to communicate through dreams, natural signs, and illnesses. This is when AmaNdebele perform rituals and special prayers as ways to appease the supreme beings. Traditional health practitioners are also acknowledged because they are believed as tools of communication between the physical and spiritual world. Therefore, there is a relationship of the physical and spiritual world and traditional health practitioners established the bridge of communication. This was confirmed by a participant who stated that:

> *"Thina sibabantu abakholelwa kuZimu nebezimu. Sikholelwa bona ngibo abasivikelako nebasikhambela ngaphambili. Ngaphandle kwabo umkhanyo nepumelelo azikho. Yeke, iinyanga nezangoma ngizo ezinekghono lokusihlanganisa nabo. Nawumumuntu ofananjengami onganaso isipho, ngeze wahlathulula bonyana lokho kwenziwa njani".* We believe in the existence of God and ancestral gods. We believe that they protect us and lead the way. Traditional health practitioners have the gifts and ablitlties to connect us with the spiritual world. An ordinary person like me does not understand the process.

During the ritual ceremonies, traditional beer is made by women as a tool to communicate with ancestors. The presence of the traditional beer called *utjwala* (see Figure 5.1) symbolizes the presence and protection from the ancestors. The

traditional beer is poured inside a traditional calabash for ancestors (see Figure 5.2) and the rest is drank by married men only during the ceremonies (see Figure 5.3)

Figure 5. 1: Traditional beer made for ancestors during a ritual ceremony

Figure 5. 2: Traditional beer in a ritual ceremony called *iqude*

Figure 5. 3: Married participant sitting close to his traditional beer.

Customary laws including taboos are also bound by belief systems. The findings of the study state that there are laws associated with religion and spirituality within the culture. Women are believed to carry divine powers and abilities hence they are custodians of AmaNdebele mathematical artefacts and participate mostly in ritual ceremonies. They are however, restricted in other secret rituals, which are only performed by men. According to the laws of the Ndebele, it is a taboo for women to perform practices done by men and vice versa. Anyone who does not follow laws stands to face the wrath from the ancestors and fines from traditional leadership, depending on the sin.

Customary laws and beliefs of the AmaNdebele state clearly that the knowledge of mathematical artefacts is passed down from mother to daughter using indigenous methods and techniques formulated many centuries. Furthermore, according to levels and age group, this knowledge is shared. It is the duty of men to also teach males activities such as hunting and the hearding of cattle. Different knowledge associated with men is also shared according to status and level.

It is also believed that mural art is a communication tool that the Supreme Beings instructed the AmaNdebele to use. Therefore, the origin of this cultural expression was an instruction from higher being and based on such, it was established and used for culture identity. The AmaNdebele also believe in honouring their leaders who have passed on through annual commemorations explained in chapter 6. This is the time where certain secret rituals are done, and livestock is slaughtered to communicate with the spiritual world. Not everyone participates in the sacred rituals, but only selected people based on their status and level.

Some concerns, which were raised by participants, is the modernization of the AmaNdebele spirituality and religion. They have stated that most people have converted into Christianity and follow modern ways of doing and living. Because of such transformations, their practices are contaminated because laws are no longer properly followed. This has then brought bad luck within the nation, which includes sickness and the death of ritual participants such as male initiation. They believe that these are the signs that the supreme beings are not happy with the modernization of Ndebele religion. In support of the statement, participant 2 further elaborated that:

> *"Mntazana, la sisepini. Abezimu abakathabi nakancani ngombana sivanga isikhethu nesikhuwa. Sisebenzisa izinto zabanye abantu begodu sizithatha sizenze zethu. Le akusingiyo indlela begodu ngikho esikhathini esinengi sizifunyana siflathelwe bezimu begodu sembeswe nalilifu elimnyama thina simaNdebele".* My girl (referring to the researcher), we are in a fight because the ancestral gods are not happy with how we are doing things. We are currently mixing our ways of living and doing with modern ways. We are using other people's knowledge as ours. This is not hot things should be done hence the reason why we are experiencing bad luck. By diverting

As it has been stated above that Ndebele mural art serves as communication, the Ndebele beadwork also has symbols which will be discussed in Chapter. Traditionally, colours used in AmaNdebele artefacts has cultural meaning and symbolism. This aspect was covered in a Master's dissertation of the researcher, (Bhuda, 2019) and was not part of this study's scope. Therefore, the study limited itself to the meaning of Ndebele shapes which are discussed in the next section.

5.3.3The symbolic meaning of shapes found in AmaNdebele mathematical artefacts

This section of this study presents results about the meaning of Ndebele geometric designs. The Ndebele artefacts consist of the following shapes: Triangle, rectangle, squares, circle, zigzags, diamonds, chevrons, horizontal lines, and perpendicular lines. Each mentioned above shapes have cultural significance and meaning, which are discussed below.

Triangle

In the AmaNdebele culture, a triangle represents the past, present, future and how they are interlinked. For instance, the Ndebele people had a different culture before the 19th century when they lost the war. The sudden disturbance of their culture in the past affected their present and continues to affect the future. The experience of the Ndebele has influenced their current worldview and that has momentum to have an impact on their future. The great impact of the Mabhoko war in the AmaNdebele's lives cannot be ignored as it has changed their lives drastically and forced them to develop other methods of surviving. Furthermore, the Ndebele people were later disturbed by the apartheid legislation where they had to vacate their land and were forced to leave their environment and homesteads behind and relocated to what is now known as KwaNdebele and other areas in the Mpumalanga province.

A participant in her own words stated the following regarding the effects of Mabhoko war:

> *"Ipi namakhwahlana yasithikameza khulu simaNdebele. Kunengikhulu okwatjhugulukako emaphilweniwethu ngombana abanengi balahlekelwa maphilowabo. Amasiko wethu watjhuguluka khulu ngaphasi kombuso wamaBhunu. AmaNdebele babantu abatlhoriswa khulu emoyeni nemzimbeni. Ipi namaBhunu yasenza inyanda yinye begodu sathola isibindri sokuragela phambili. Imiphumela engizikhakhazisa ngayo yalezonkathi mgwalo wesikhethu ekwabangiwo ohlanganise AmaNdebele waba ngendlela owabonangayo."* The war with the white people highly affected the Ndebele nation. There is a lot which changed in our lives because most of the people died. Our culture and worldview changed under the leadership of the Afrikaners. The AmaNdebele have been tormented by the Boers also

physically and mentally abused. The war with the Boers united us as the Ndebele nation and we received courage to move forward. The results that I'm proud of that period are the Ndebele beadwork and mural art which united the Ndebele people as we see them today.

Another participant argued that:

> *"Umlandu wepi yamaNdebele ungumphumela walokhu esikubona namhlanje. Kunebudlelwano hlangana nomlandu wamaNdebele, neentjhijilo abehlangane nazo kanye nengomuso lamaNdebele. Koke lokhu kuhlangene begodugu ngeze kwahlukaniswa".* The history about the Ndebele is the outcome of what is seen today. A person can never separate the past, present and the future of the Ndebele nation because they are connected an form part of the Ndebele culture and identity.

Squares and rectangles

In the AmaNdebele culture, both squares and rectangles symbolize the earth (physical world) and the cosmos (spiritual world), with its four sides marking the junction between these two entities. The shapes are seen as holistic as they can be associated with femininity thus woman gives life (creation) and is responsible for the reproduction of the world. In the AmaNdebele culture, women are seen as beings that carry divine powers which have an ability to bring something into life/ existence.

While interviewed a participant highlighted the following:

> *"Umuntu wengubo thina safundiswa bonyana mumuntu onekghono lokuveza okufihlekileko. Isibonelo singasibona emgwalweni wesikhethu la kufihleke khona imilayezo. Yindlela adalwe ngayo emenza bonyana abanekghono lokwenza izinto abantu bembaji abangazikghoniko. Njengoba wakhethwa bezimu bonyana umgwalo wesikhethu wenziwe nguye, kuyatjengisa bonyana unamandla wokwakha".* We were taught that a female has an ability to reveal what is hidden. An example can be seen how hidden messages are perfectly infused in the Ndebele beadwork and mural art. It is how a woman was created which makes her have capabilities of doing things men cannot do. Because she was chosen by the ancestors to

be the gatekeepers of the Ndebele art, it shows her powers of producing and creating.

Circles

In the IsiNdebele culture, a circle is not only associated with beadwork and mural art but also with the knowledge shared within the nation. The AmaNdebele believe that knowledge is from the higher beings known as *abezimu* and *Zimu*. Knowledge is seen as circular; it is shared from one generation to another and never ends. Mothers can share knowledge to their young ones. A circle is holistic because stories around the fire about culture and history are turned into songs that are sang in daily life so that children can never forget.

One of the participants stated the following:

> *"Ilwazi libuya ebezimini kanye no Zimu, lize kithi ebantwini nasiqeda la silidlulisele phambili kunzukulwana zethu. Ilwazi lingafaniswa njenge ndingiliza, alipheli."* Knowledge is from the ancestral gods and God then it is sent to us so that we can be able to transfer it to the next coming generation. Knowledge can be associated with a circle, as it never ends.

Zig zags shapes

The AmaNdebele have formulated a strong bond with the ancestors during the dark days they faced since the colonizers settled in Africa and went to war with them. The AmaNdebele have been following the guidance of the ancestors/gods/higher beings throughout their lives. The parallel zig zags remind the AmaNdebele to obey the path of the higher being and that nothing in life is straightforward and the path will be difficult to follow.

Diamond shape

A diamond is two combined triangles facing upside down. This is shape of royalty, and mostly dominates the walls of the royal compound including the attire of royals. The AmaNdebele believe in traditional leadership and the shape symbolizes the honouring of leadership that stood the test of time and faced trials and tribulations in the past. It should be constantly mentioned that the AmaNdebele of Ndzundza went to war with the Boers and during that time, the preservation and protection of traditional leadership

was the main priority. It is still believed today that AmaNdebele royals should be honoured and are the chosen ones to lead the people. The Ndzundza kingship and leadership was the main target of the Boers and that can also be seen on how kings like Nyabela were imprisoned and tortured with the aim of destroying traditional leadership.

Chevrons figures

A chevron represents how the physical world, and the spiritual world are not two mutually exclusive realms. It is believed that the two realms are connected. Chevrons are known to teach people how to use the material world so as to achieve spiritual realms. The shape(s) represent the connection the AmaNdebele have with their God and ancestors. In addition, chevrons represent the bridge of communication the AmaNdebele established with spiritual world. Such opinions could be supported by the facts that the AmaNdebele strengthen their relationship with the spiritual world during and after colonialism. The AmaNdebele rely on ancestral gods for guidance. A participant of this study stated the following:

> *"AmaNdebele anobudlelwano nabezimu obuhlekhulu kwamambala begodu uZimu naye owakhe koke esikubonako asimrhapheli ngaphandle. Sibabantu nekolo yezomoya begodu sinethemba bonyana nasikholelwa entweni ethize kuzokuphethakala".* The AmaNdebele have a great relationship with the gods and not forgetting God who is the creator of the universe. We are religious people who have hope that if we believe, we shall be granted with our partitions.

Horizontal shape

The horizontal shape is known to represent the path from birth to death, the beginning to end, and linear time. The horizontal axis represents life on earth as a binary, linear process, life to death, beginning to end, and the dual nature of human existence. There is a relationship between birth and death and using this shape for symbolism and communication purposes by the AmaNdebele is a way of conveying message that people go through different stages or processes in life in the beginning of their existence until death.

Perpendicular shapes

First, a perpendicular shape, represents a man, the body, and the human upright posture. The vertical line symbolizes the way from earth to the cosmos (the domain of spirit), symbolizing the double nature of man, who embodies the spiritual and the temporal. The perpendicular axis equates directly to the human spine and to the tree of life, as well as to the cosmic axis, the great pole around which the constellations of the zodiac revolve.

The most interesting fact about the perpendicular shape is the link it establishes between the earth, cosmos, and human beings. This explains the relationship the AmaNdebele still maintain with the spiritual world and their belief system that they originate from the cosmos. Explaining the meaning of perpendicular shapes, Participant 2 stated that:

> *"AmaNdebele anobudlelwano obunzinzileko noZimu nabezimu begodu thina sikholelwa bonyana asibabantu bakuleli phasi."* The AmaNdebele have a relationship with God and gods also, we believe that we are not of this world.

5.4 Discussion

5.4.1 Introduction

This section of the study investigated the cosmic genesis of the AmaNdebele mathematical artefacts. The discussion below emerged from the findings of this chapter and similar studies done on the same topic.

5.4.1.1 Meaning of shapes

The symmetrical geometric shapes that are found in the AmaNdebele artefacts have symbolic meaning. The meanings of the geometric shapes are connected to the cultural belief systems of the AmaNdebele. They are perceived as part of the AmaNdebele spirituality. These findings are supported by the Indigenous theory guiding this study, which is rooted in indigenous people's beliefs, worldviews, knowledge, and culture. The theory acknowledges the African ways of doing, living and being while also challenging and reframing narratives around African indigenous knowledge systems.

Idowu (1973) acknowledges that in different sections of Africa, the bulk of African art performs varied roles such as funerals, initiations, and celebrations, according to (Idowu, 1973). Whichever form a work of art takes in an African environment, such as

sketching, painting, carving, or casting, its religious function focuses on rituals, ancestral worship, deity worship, and rites of passage for loved ones. Africans believe in the presence of a supreme entity that is in charge of the universe's events (Ibid, 1973). This can be seen in their ceremonial monitoring of ancestral spirits and deities, as well as their devotion or appeasement of them in regard to their belief in the Supreme Being.

The traditional African belief was (and still is) that there is an ultimate entity that can only be reached or approached through an agent or divinity. From land to land and culture to culture, this agent or divinity takes various forms, objects, and materials. Carved wood, clay, stone, and other materials are used to depict some of them. Culture is made up of patterns implicating commands of behaviour obtained and transferred by symbols constituting these destined accomplishments of human groups, including their incarnation artefact (Azeez, 2010).

Fourie (1921) defined the Ndebele religious beliefs as believing in the Supreme Being/god known as Zimu or mlimu, as well as the supreme ancestral gods known as abezimu. According to Levy (1990), Ndebele cosmology (spirituality) has an influence the artefacts practised within the culture. In support of Fourie (1921) and Levy (1990), similar studies that were conducted by Azeez (2010) highlight that regardless of language or culture, African art has one thing in common: the bond between art and religion. From the south to the north, and from the east to the west, the African continent has a distinct commonality. Making an example of the Egyptian artefacts, the Egyptians' belief in life after death caused the wealthy and powerful to go to great lengths to ensure that their bodies were kept indefinitely. That is why the pyramids and rock tombs were so costly to create. The Egyptians advance in the field of grave or tomb building and the work of art used to beautify the tomb and ancestral resting place of their loved ones thanks to the worship of ancestral Egyptian mummies (Rukeme, 2000). The Egyptians' belief in numerous gods was also a driving force behind their art.

Research studies that have been made by scholars on African geometric shapes concur with the results that were presented in the study. Ayiku (1998) whose PhD study focused on symbolic meanings in the Ghanaian arts stated that the circle, rectangle, and triangle, to name a few, all have significant symbolic implications and

significance in Ghanaian culture. As a result, there are certain symbolic aspects inside any artistic form that collectively give it its overall meaning, purpose, and significance. According to several academics, the varied geometric shapes in African civilizations have symbolic meanings, which are listed as follows:

Triangle symbolism

An anthropologist, Apetroaie (2013) who conducted a study on the motifs and meanings of North African tattoos stated that a trinity is symbolized as a triangle. A triangle inside this group, as a three-sided polygon, represents the spirit, mind, and body, and how they are all interconnected. A triangle, with its three sides, can also signify life and family, with the base symbolizing birth (of the universe) and existence (realization of one's self and destiny).

According to Badoe and Opoku-(2014) Asare's research on Asante Kente attire, the triangle in the textile symbolizes life and family. The foundation represents both birth (of the world) and existence (realization of oneself and destiny). The summit symbolizes both bodily and spiritual death. The three sides indicate the merger of masculine and feminine elements that unite to give birth to a third principle, like the father and mother giving birth to a child or the brain and heart giving birth to will-power. In essence, the triangle denotes completion; it depicts a man's life.

Xulu (2002) and Zungu (2000) stated that amongst the Zulu people, a triangle has different meanings which are influenced by its position in beadwork. As mentioned before, an inverted triangle (apex pointing downward) means the unfulfilled or unmarried man; or be arranged with the apex pointing upwards, inferring the unfulfilled or unmarried woman; or be joined with another triangle along the base to outline a diamond to speak to the total or wedded woman; or be joined to another triangle with apexes meeting in an hourglass shape, to symbolize the total or wedded man (Xulu, 2002; Zungu, 2000).

Square and rectangles symbolism

The square and rectangles have four sides which are associated with material things, the physical elements, the direction of the world, and the seasons of the world. According to the Bantu speaking people, both the square and rectangle are the symbol of the material world itself (Ayiku, 1998). The earth and the cosmos are symbolized by a square, which has four sides that represent the intersection of these two entities.

Because a woman gives life (creation – procreation), it is associated with femininity. This shape appears frequently in the kente as a reminder of the Akan society's matrilineal nature.

Circle symbolism

According to Ayiku (1998), the full moon is symbolized by a circle. It symbolizes the existence and power of God's spirit in society. Mile the circle is not a religious symbol. Although the Ghanaian does not represent God figuratively, the smooth curvature of its shape does represent the flawless aspects of God's spirit — holiness, sanctity, and purity. Its continuous circumference also represents the cyclical nature of natural occurrences, implying the life-infinity. force's The cycle appears in the plans of most holy artefacts such as shrines and temples built as abodes for ancestral spirits and other supematural deities where information is passed down and hidden rites are performed as a symbol of purity and sacredness. This concurs with the eZiko Sipheka Sisophula theory used in this current study which states that African indigenous knowledge is circular in nature and as indicated by the circle, it is holistic around in which spiritual, intellectual and psychological rituals, dialogues and intergenerational and intercultural teachings take place (Ibid, 1998).

Zig-zag symbolism

All Voltaic peoples' masks, including Mossi masks, Dogon masks (and the walls of caverns in the Dogon cliffs), and Bwa plank masks, are thought to constitute "the route of the ancestors," which is visible to everyone who attends the mask performance. The zigzags, as per Roy (2019), reflect the ancestors' path. The ancestor's road serves as a reminder to individuals who follow the norms established by their ancestors and do things the way they did in order to live a successful and tranquil life. People must honour their ancestors in order to follow in their footsteps, and they must function as mediators with the spirits of nature in order for them to bestow their blessings on their descendants.

Diamond shapes and symbolism

The Ashanti people of Ghana are another African civilization that embraces the diamond shape. The shape may be found in the Ashanti monarchs' kente attire, which they wear during important rituals. It represents the monarch's existential duality as a

chief (the bottom triangle) and as a human (the top triangle) (the top triangle). It is thought that the two are intertwined and that his fates as a king and a man are intertwined: all his actions as a man and a king, work to ensure his survival and that of the royal customs (Ayiku, 1998).

Vertical and horizontal shape symbolism

The Kanaga masks for instance are based on the interplay of vertical and horizontal lines and shapes. These masks as stated in the literature review chapter, are worn during the Dama dance and are believed to create a bridge between the living and nonliving. Interestingly, the masks also appear during baga-bundo rites performed by small numbers of masqueraders before the burial of a male Dogon (Van Beek& Benjamin, 1991).

5.4.1.2 Taboos associated with the AmNdebele art

There are taboos associated with AmaNdebele artefacts. These taboos have been influenced by cultural beliefs and religion. The cultural taboos differ from being gender-based and religiously related. Either way, both AmaNdebele women and men are obliged to adhere to the customary laws that have been in existence for a long time in the Ndebele nation. The taboos in the Ndebele culture have assisted in maintaining order and preserving culture.

Similar studies, which have been conducted in the Kuba cultural groups, indicate that boys from the southern Kuba groups may attend an initiation camp in the bush, where they are taught hidden verbal and performance arts, as well as how to make costumes and masks out of natural materials. "The making and dancing of masks is integral to the secret knowledge passed from elder to junior during the rite" (Binkley, 1990:160). The stringent taboos connected with participation in secret societies, as well as the sanctions against disclosing secrets, assist with the preservation of tradition and the transmission of knowledge and ritual practice from one generation to the next.

Idang (2015) argued that although there are many taboos associated with material culture because it tangible and manifests itself in the form of artefacts and crafts, non-material culture is intangible yet has a profound impact on the lives of people in each civilization. As a result, non-material culture does include attitudes about what is good and what is bad, as well as conventions and taboos (Idang, 2015).

The researcher acknowledges the reviewed work of scholars on similar topics. Indeed, the indigenous knowledge surrounding African art and artefacts provides a prouder understanding of African people's worldviews. Such research is critical because it provides detailed information on what African people perceive as reality and part of the culture. It is therefore important for indigenous and non-indigenous scholars to be guided by African indigenous philosophies that have been discussed on chapter 3 when conducting studies associated with indigenous knowledge systems in order to obtain detailed information from participants who are not made to think that their knowledge is a myth, primitive, demonic or barbaric.

Concluding remarks

The cosmic origins of the AmaNdebele mathematical artefacts were studied in this phase of the research. The chapter went on to discuss AmaNdebele's cultural beliefs and how those beliefs have inspired the artefacts used to express the culture. The chapter further identified and discussed taboos associated with AmaNdebele artefacts and how they are linked to the belief systems. It has argued that taboos as part of customary laws are appropriate because they bring law and order to the AmaNdebele nation. The Next chapter focuses on AmaNdebele's mathematical artefacts as an expression of cultural identity.

CHAPTER 6: THE CULTURAL IDENTITY FROM THE AMANDEBELE MATHEMATICAL ARTEFACTS

6.1 Introduction

As expressions of a sense of belonging and identity, AmaNdebele mathematical artefacts have attracted a considerable amount of scholarly attention which places high premium on how cultures and identities are shaped and maintained through the production and use of tangible objects. Mandelman (2014:188) stresses that there is “dialectical relationship at work in which the material objects of human worlds shape cultures and identities as much as cultures and identities shape those objects”. The AmaNdebele artefacts continue to express cultural identity, cultural resistance, and continuity.

The emerging statement is that belonging to self-conscious and deliberate articulations emerges from the creation and use processes of mathematical artefacts that are material culture captured by Mukerji (1994:146) as “…made up of objects that people both derive and distinguish from the natural resources around them to make a visibly human environment in which to organize group life,” in the creation and use of objects, identity manifests. Material culture is thus made as a key concept of examining people's experiences and relationships with material symbols in ways that enable the cultural identity of AmaNdebele mathematical artefacts which are to be discussed in this chapter.

Courtney-Clarke (1986); Loubser (1994) and Van Vuuren (2008) have drawn attention to the long history of beadwork and mural art among the AmaNdebele communities, tracing it to the 1940s, which have mentioned in their works that it has been existing before then and used as culture identity. This chapter explores the cultural identity from the AmaNdebele mathematical artefacts. To achieve the objective of this study, this chapter focuses on different AmaNdebele traditional ceremonies that serve as cultural identity, artefacts associated with culture identity and gender roles in preserving AmaNdebele identity. This chapter is guided by the following question: How do AmaNdebele artefacts serve as cultural identity?

6.2 Methodology

6.2.1 Research design

The researcher used an ethnographic research design to direct this chapter. The research spent time with participants, interacted and observed their environment and their activities then established a relationship with them, keeping in mind that the results of this study depended on that relationship. Therefore, the aim of the researcher was to use a cultural lens to study the AmaNdebele lives within their immediate communities to understand how they express their cultural identity (Hammersley, 2018; Wutich & Brewis, 2019).

6.2.2 Target population

Target population for this chapter were twelve AmaNdebele of the KwaMsiza Mabhoko community. This population was selected using a purposive sampling because of their knowledge of cultural ceremonies and commemorations which form a tremendous part of their identity. They are experts and leaders of Ndebele identity preservation and promotion.

6.2.3 Sampling size and sampling procedure

The sample size consisted of ten participants from the KwaMsiza Mabhoko community who were available for the focus group interviews. This enabled the researcher to use a convenient sampling procedure.

6.2.4 Data collection strategies

6.2.4.1 Tools

A focus group interview was used to collect data from participants (see appendix 3). The researcher needed to conduct two different interviews. One consisted of men and the other of women. According to Ndebele customary laws, women do not sit with men. Thus, separate interviews were conducted. In the case of the researcher, an exception was made because men had an interest in preserving Ndebele culture and assisting one of their own (the researcher) in doing so. An observation guide was also used to capture activities used to express cultural identity.

6.2.4.2 Methods

The interviews were conducted *ebaleni* and prior to the interviews, the researcher explained the process and participants signed research documents before participating (see figure 6.2). Each interview with the participants took 2 hours and activities and information was captured using an observation schedule. Instruments such as a camera and voice recorder were used to store data.

Figure 6. 1: Researcher with some of the participants at baleni

Figure 6. 2: Researcher explaining the study process to the participants

6.2.5 Data analysis

For the analysis of data derived from focus group interviews, a thematic analysis was used. Data collected during the interviews was first transcribed and translated from IsiNdebele into English from the voice recorders. The research was performed through the data manually. The researcher read through data files and themes were defined to verify the quality of the data (Braun & Clarke, 2014). With field notes and observations, triangulation was completed. When gaps were discovered, the researcher had to do a member check of the study area to determine its trustworthiness (Lincoln & Guba, 1986). For this chapter, the themes were reported as results.

6.2.6 Strategies of enhancing the validity and trustworthiness of the study

This tool was tested for validity by piloting it in the Mpumalanga Province, Kwamhlanga surrounding areas which is where AmaNdebele who do cultural practices reside. The pilot participants' feedback was used to determine the content validity of the focus group interview questions and observation schedule. When piloting the tool with participants, the researcher translated the focus group interview questions into

IsiNdebele. On the observation schedule, the same procedure (changing the language) was applied.

The researcher wanted to make sure that the language used in the interview, as well as the length and order of the questions, was correct. As a result, the researcher condensed the length of the questions, selected a local language that women understood, and arranged the questions in a logical order. The researcher was able to make follow-up inquiries as needed because of the way the questions were organized. To generate trustworthy data, multiple data-gathering tools such as a tape recorder, camera, and diary were employed to assist the data collection tool (Carter et al., 2014).

6.3 Results

6.3.1 Introduction

The themes that were identified during data analysis will be presented as follows for this chapter: Mathematical artefacts used for ritual ceremonies; mathematical artefacts used by men and women and mathematical artefacts used to celebrate the identity of the AmaNdebele. A theme that emerged was as follows: mathematical artefacts as part of the initiation process for both boys and girls. Results from an observation schedule are also presented in this chapter.

6.3.2 Mathematical artefacts used for ritual ceremonies

Within the Ndebele culture, women are handlers of mathematical artefacts and participate more in ritual ceremonies which form part of the Ndebele identity. They are responsible for making artefacts such as beadwork and mural art. They also design beaded attires for the AmaNdebele according to ages and status. The duty of men is then to wear beaded attires during ceremonies. These beaded attires are less detailed and sophisticated compared to those worn by women.

AmaNdebele women generate their own hierarchies and levels of power, typically without local and tribal political authority and rank in the male dominated world. This hierarchy, within the ritual meaning paradigm, represents lower levels of entry into the system and advancement to the upper ranks of the internal ritual ranking system after time. It is enough to say that this promotion runs parallel to that of the increasing socio-biological status of a woman: by marital status, motherhood etc.

Women dress in a variety of geometric beaded garments, determined by generation and social class, and often sing and dance during the ceremony period (see Figure 6.3). Firstly, these different statuses crosscut and reinforce ritual rank, secondly, decide location and movement within the ritual arena, and thirdly, determine verbal involvement. These findings were supported by participant 3 when she stated the following:

> *"Thina abantu bengubo sinendlela asivunula ngayo nakuneminyanya begodu ngiyo ehlathulula ubujamo bethu neminyakayethu. Ivunulo yesikhethu inemithetho begodu neminyanya yesikhethu ihlukahlukene. Yeke, ayikhanjelwa ngunoma ngubani ngombana sinemigomo nemibandela simaNdebele."* We as women have a way of dressing during ritual ceremonies. This way explains our status and age group. Our attires have terms and conditions in a way that not everyone wears the same and not everyone participates in the ceremonies.

Beadwork has a long history of association with the AmaNdebele community as a significant conduit where basic cultural definitions of Ndebele identity are formed. Without exception, the traditionally enduring essence of beadwork has provided a distinctive cultural identity to the AmaNdebele community.

Figure 6. 3: women wearing geometric beaded attires and dancing during a ritual ceremony.

Besides beadwork, mural art also plays a fundamental role in ritual ceremonies. A common statement from interviewees' narratives of emphasizing women's role was that "a woman needs to master painting to express Ndebele identity in her home and continue renewing the paintings during the period of ritual ceremonies (see figure 6.4) as renewing paintings is seen as way to communicate with the entire community. In AmaNdebele communities, wall-paintings were essentially depicted as an expression of traditional ideals of women as an integral part of a family. Nearly all elderly women with whom the researcher had discussions with on wall-paintings shared a sense of attachment by uttering comments such as "it is part of exhibiting one's womanhood; it is our territory" in ways that mirrored the observation of the researcher (see figure 6.5).

They also emphasized their positions in adhering to the tradition of wall paintings in ways that offered additional insights into how women were valued as guardians of the identity of Southern Ndebele and shaped and preserved cultural conceptions of motherhood significantly. An elderly woman who described her experience with wall paintings as a long-standing one, dating back to the early 1970s, as follows in a richly instructive account:

> *"Abantu bengubo kufuze bamumathe ilwazi lokugwala ngombana liqakatheke khulu kithi. Yindlela esikhulumangayo nesitlola ngayo nesindlulisa umlayezo ngayo simaNdebele. Nakuneminyanya, kubonakala ngomgwalo ovuselelweko emzini. Lokho kithi kuba simemo."* Women need to master painting as it is forms an intergral part of our culture and identity. It is a form of communication and writing system we as AmaNdebele have been using for generations. When there are ceremonies in certain houses, we see by the renewal of their paintings. That on its own is an invitation. Therefore, this knowledge is very important to our people.

The above account was echoed by others, confirming that wall-paintings are a constitutive element of the identity of Southern Ndebele that affirmed the position of women as cultural nurturers by making statements such as "yes, through these wall-paintings, we maintain our culture and transmit the knowledge to the younger generation".

Figure 6. 4: A house getting prepared for painting before a ritual ceremony

Figure 6. 5: Researcher observing how AmaNdebele women do their mural art

6.3.2.1 Mathematical artefacts as part of the initiation process for both boys and girls

The transition between some southern AmaNdebele communities from adolescence to adulthood is indexed by culturally grounded initiation ceremonies. In establishing, recreating membership boundaries, and forming conceptions of belonging, these initiation ceremonies bear tremendous significance. Initiation practices have gained

significant scholarly attention as culturally grounded practices that form social identities and are widely used as rites of passage to mark the transition from boyhood to manhood and girlhood to womanhood.

From the data gathered, it is evident that the AmaNdebele use initiations as an expression of belonging and as a symbol of their cultural identity. Therefore, it was imperative to learn further on how through initiation a sense of Ndebele cultural identity is expressed and ingrained.

Role of mathematical artefacts in male initiation

According to customary laws, male initiation is highly centralized and controlled by the royal house that has absolute monopoly over authorizing male initiation. As the guardian of culture, after carrying out particularly relevant traditional rituals such as making an offering, the King is the only person with authority to officiate and pronounce on the practice of initiation.

The emphasis on the centralized existence of initiation can be interpreted as a reflection of how institutions primarily guarantee their positions as guardians of cultural norms and how traditional practices are mobilized to claim an awareness of belonging to the identity of AmaNdebele. Explaining generally about the laws that surround the initiation process known as *ingoma*, a participant stated the following:

> "*Ingoma iwela ngemva kweminyaka emine, begodu abobaba ngibo abaya ngesgodleni batjele ingwenyama bonyana bakhulele bentwana. Leli likhambo elingelabo baba kwaphela, begodu abomma abatjhideli kilo nelwazi lokobana kwenzakala ini abanalo. Umsebenzi wabo kulungiselela ukubuya kwamasokana* ". Ingoma takes place every four years lead by men under the authority of traditional leadership. Men are responsible for the entire process without the interference of women. Women have no right to know what happens during the process. Their role is to prepare for the return of the boys from the intitiation schools.

Based on the evidence gathered from interviews, traditional authority/royalty is responsible for the entire process and preparation. Local men who have undergone the initiation take instruction from royal authority. Initiation happens between May and July. Ultimately, the tradition of initiation rituals requires the presence of the entire

AmaNdebele community in the planning stage before the ritual starts. The year of 2021 was supposed to mark another initiation school process (see Table 6.1). However, due to Covid-19 pandemic which became a global crisis, the AmaNdebele male initiation did not take place and the researcher was unable to observe the ritual ceremonies done. The researcher had to rely on existing original pictures and experiences she has encounters as a Ndebele to have a clear understanding of the processes. Letters of the male initiation process cancellation have been provided in chapter 8.

Table 6. 1: List of Ndzundza Mabhoko male initiation

Intanga	**Igwabo**	**iminyaka yokuwela**								
amaSinya	Yifasimbi (intuthu emhlophe)	1540	1600	1660	1720	1780	1840	1899	1959	2017
amaPhogo	yiZingwana (Madlambuzi)	1544	1604	1664	1724	1784	1844	1903	1962 & 3	
amaRhorha	MaPhaswana (Maqothantethe)	1548	1608	1668	1728	1788	1848	1907	1967	
amaNghana	yiGeze (inyoni emhlophe)	1552	1612	1672	1732	1792	1852	1911	1971	
amaDuba	MaBunzwana (Kung'emnyama)	1556	1616	1676	1736	1796	1856	1915 & 7	1975	
amaDlowu	Mafelakude (maganadlha) (madlanga)	1560	1620	1680	1740	1800	1860	1919	1979	
amaDlhari	LiBasa (Malisa'mkhonwan)	1564	1624	1684	1744	1804	1864	1923	1982	
iNyathi	Malinga (Ngudukuza ongafiko) (siquntwana sentonga)	1568	1628	1688	1748	1808	1868	1927	1985	
amaRudla	maSebelanga	1572	1632	1692	1752	1812	1872	1931	1989	
amaGawu	Mdlwambuzi (Mphongolo)	1576	1636	1696	1756	1816	1876	1935	1993	
amaDzibha	Mbavumana	1580	1640	1700	1760	1820	1880	1939	1997	
amaThula	amaGwa	1584	1644	1704	1764	1824	1886	1943	2001	
amaDlaza	Sigeda buthuvi, (iqhubabulongwe), mavimba ngomkhonto ebukhalini	1588	1648	1708	1768	1828	1888	1947	2005 & 6	
amaRhasa	yiPakama yeensiba ezibomvu, (Mdlakomo)	1592	1652	1712	1772	1832	1892	1951	2009	
amaDugu	Mhlwazi	1596	1656	1716	1776	1836	1896	1955	2013	

As a woman who is Ndebele and who understands customary laws, the researcher was constantly reminded of her position and limitations when it came to information

regarding the initiation process. Male participants were kind enough to share some information with the researcher about the evidence of mathematical artefacts during the process when boys are in initiation schools. One participant stated that “there is no beadwork or painting where boys are kept during the process. Those things are left behind at home and the boys only wear beadwork after they have returned from being initiated”. This statement by the participant was to assure the researcher that the scope of this study did not need to further look deeply in the details of initiation and interfering in men’s affairs.

Therefore, because this study never aimed at going into detail on the initiation processes and sacred rituals, the information that was shared by the participants was enough for the scope and focus of this study. The study then looked at ceremonies done in preparation of the return of the boys. Findings of the study state that women become leaders of certain rituals in communities which happen before the return of initiated boys also known as *amasokana.* Women perform a ritual called *ukugida igwabo*, which is a ceremony that indicates the celebration of boys who will enter the manhood state. *Elderly women and women who have sons that are undergoing initiation in the period do Ukugida igwabo*. They further do *ukuthokoza* which is a process of visiting homes where initiation ceremonies will take place. This is a way of supporting each other and showing unity. They adorn themselves with sophisticated beaded geometric attires that are strictly for that ceremony as shown in figure 6.6.

Beadwork known as *imilingakobe* and *umkhala* can be worn only by a woman whose son is at that time, at the initiation school. No other woman is permitted to dress up in these ornaments, or if it is not an initiation season, everyone is allowed to wear them. *Imilingakobe* is a lengthy striped beadwork object worn to hang from head to toe. They are worn by females only and never by males. They are worn especially, to hang on either side of the head, normally well decorated with colourful beads and geometric shapes. They are also thought to be used as indicators of the status a woman has attained in life, that is, a status of being mother to an initiate. *Umkhala* is a circular beaded headband worn during ceremonies.

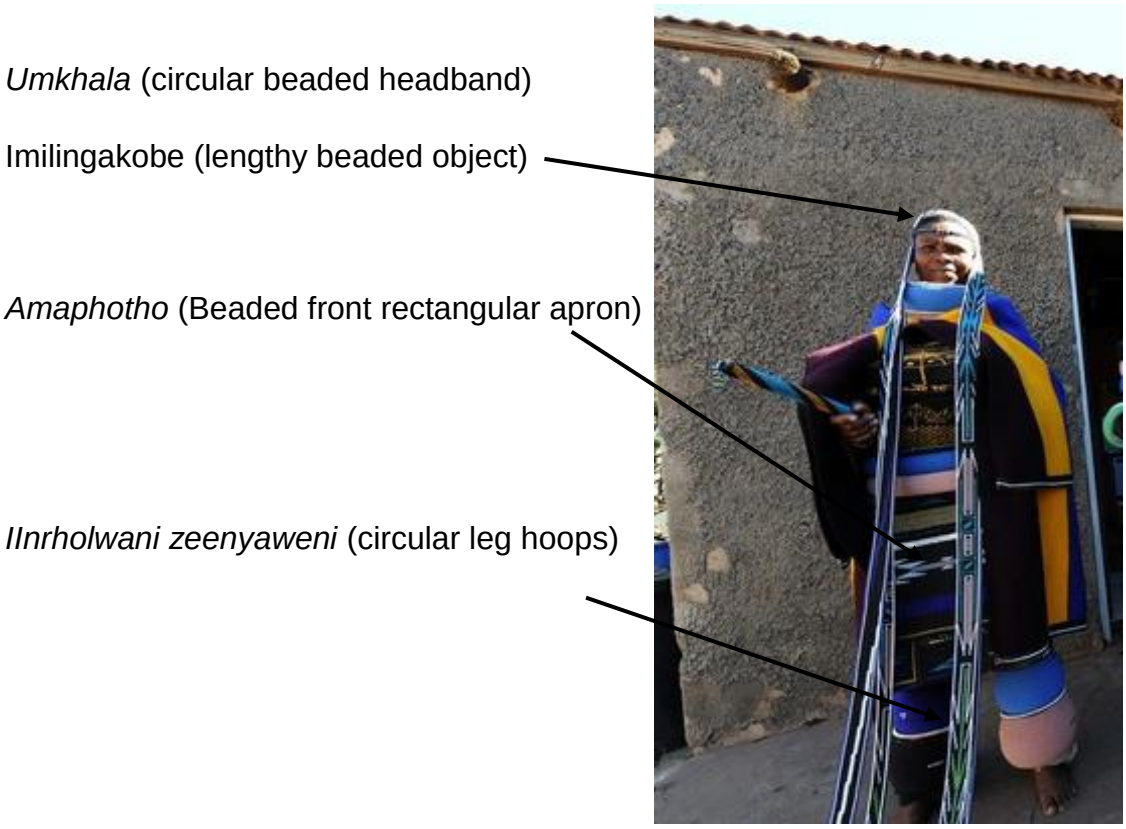


Figure 6. 6: A mother of an initiate wearing a beaded attire, a pair of *imilingakobe* and a circular headband known as *umkhala*.

After undergoing initiation, *amasokana* are welcomed back home through a ritual ceremony. Dressed in what is perceived to be Ndebele beaded geometric regalia, initiates' mothers sing and ululate as they welcome new initiates who are wearing beaded whoops (see figure 6.7). Male beaded attire shows to be less detailed as compared to females which will be discussed next in this chapter. One of the participants whose son was initiated in 2013, stated the following:

> *"Ngathaba khulu lokha umntwanami uyokuwela ngombana wanngena esgabeni esitjha sepilo. Ngizikhakhazisa khulu ngamasiko wethu ngombana asibumbela abentwana begodu nabarholi bangomuso. Nawungibona nje, ngingumma ozibetha isifuba ngokuba liNdebele. Ingoma iqakatheke khulu kwamambala ebantwini bekhethu begodu ngithabe khulu ngombana umndenami ubeyingcenye yengoma"* I was very happy and proud when my son went to initiation school and when he entered another level of his life which is manhood. I am proud of being a Ndebele woman and I still follow our traditions and

customs. *Ingoma* is very important to our people, and I am glad that my family had experienced its greatness.

Many of the women whose sons had successfully completed the initiation process and were gathering in a specific household is recalled in the phrase above. These cultural practices give them a sense of belonging with the rest of the community and make them increasingly clear from other ethnic groups as most women interviewees who did not have sons who were initiates stressed that they had come to celebrate with the mothers of the initiates as AmaNdebele community.

Figure 6. 7: New initiates wearing their beadwork during a welcoming ritual ceremony

As if it were by law, grown-up men do not indulge much in bead wearing. There are only a few pieces worn by men that are beaded. A necklace made up of a string of medium-size beads may be among them. The wrist will occasionally have tiny, beaded strings around it. During initiation, the wearing of plenty of beads by grown-up men is

discovered. The father of the young initiate will be found wearing what is called *iporiyana* during this time (see figure 6.8). This is a rectangular shaped animal skin that sometimes ends with a tassel at the bottom to cover the chest.

This is a rather significant piece of clothing among the people of the Ndebele. It shows that the wearer is now a mature married man, probably among the initiates with a son, and is a well-respected individual in society. However, his friend and age mate at a special function, who is married, an *iporiyana* is conferred on his owner. It is customized to be attached to the neck with a harness. *Iporiyana*'s upper portion is the one that gets a lot of beadworks. It normally consists of a belt-like bead that extends from left to right.

Figure 6. 8: Father of an initiate during a ceremony, wearing *iporiyana* and circular thin neck hoops.

Role of mathematical artefacts in female initiation

Even though female initiation sharply differs from male initiation in terms of how it is conducted and the duration of the initiation process, beaded attires worn by women who take charge of the process are not that different from those worn during the male initiation process. Directly opposed to male initiation on a quadrennial basis and approved by the initiation of the royal house, female initiation is individually organized at the level of the homestead.

As a woman, the researcher was able to be present during the initial stage of the female initiation called *iqude*. Based on the relationship she has established with elderly women who were part of the female initiation process, the researcher managed to create rapport and asked questions on female rituals and mathematical artefacts. She was able to further explore and get an understanding of how mathematical artefacts are related to female initiation, which is an integral marker of Ndebele's identity, based on the questions asked. Only close relatives, neighbors and friends seemed to be attracted to female initiation. The need to engage with the questions of how female initiation establishes attachment to Ndebele identity in comparison to male initiation was then derived from this.

Speaking to an initiate's mother as the starting point helped the researcher gain insights into how to validate and assign one's relationship to Ndebele identity through initiation. It was a common thread, which dovetailed neatly with what was articulated by many male initiates, that there was some sense of pride and joy in expressing consciousness of belonging through initiation. For instance, a participant who had her daughter initiated in 2020 saw *iqude* as:

> "…*Ingcenye yesikopilo yamaNdebele ekufuze ivikeleke begodi igqhinwe. Kuqakatheke khulu kwamambala bonyana abentazinyana bathombe, bakhule babe bafazi begodu bazikhakhazise ngokuba maNdebele."* …is part of the Ndebele culture which needs to be preserved and protected. It is very important for young girls to be initiated so that they can be prepared for womanhood and for them to embrace their identity.

It is clear that there is a correlation between some elements of Southern Ndebele values and initiation, but ambivalence about initiation was expressed by some initiated

girls. Whereas, as for many, the practice of initiation was considered necessary to create some degree of connection with Ndebeleness.

The researcher observed that on the Friday of *iqude* which is the initial phase, girls called *abangenisi* (see figure 6.9) who are guiding the initiate, wear their beaded mathematical attire and dance in front of the community, embrassing their culture and identity (see figure 6.10). The family of the initiate also gives them gifts on that day as a token of appreciation for guiding their daughter (see figure 6.11)

Figure 6. 9: The researcher with the initiate's female guiders/guides known as *abangenisi*

Figure 6. 10: *Abangenisi* dancing and wearing beaded attires as a way to embrace their culture and identity

Figure 6. 11: *Abangenisi* holding gifts from the family of the initiate

On the Saturday evening, elderly women and those who have daughters that have undergone initiation process gather in their beaded attires and dance. This is still considered as part of the *iqude* ritual ceremony (see Figure 6.13). Women attire specifically aprons differed according to her status within the community. There are

two aprons which Ndebele women wear, and they are *itjorholo* and *amaphotho*. (See Figure 6.12) which will fully be discussed later in this chapter.

A: itjorholo B: Amaphotho

Figure 6. 12: Ndebele aprons for women

Figure 6. 13: AmaNdebele women dancing during *iqude* ceremony as a way to embrace their culture and identity.

On the Sunday which is the last day of the initial phase of *iqude*, the mother or representative of the initiate becomes the only person wearing beaded attire and she enters the room where all other women are sitting then thank them for partaking in the process. This however does not mean that the *iqude* process has come to an end. Rather this is the initial opening ceremony of a month *iqude* process. After iqude, umhlubulo ceremony follows where the initiate appears in public for the first time as a

maiden. She is clothed in beaded rectangular apron known as *iphephethu* that symbolizes her status as a maiden and colourful circular hoops (. See figure 6.14). She dances in front of spectators as a way of celebrating her new level and status in the community. This is the same attire won by the initiate's guiders on figure 6.9, figure 6.10 and figure 6.11. The only difference is the circular hoops in the arms which are only worn by the newly initiated girl.

Figure 6. 14: Newly initiated girl during the umhlubulo ceremony

Therefore, based on the results of the study, it is clear that women embrace their identity and culture using beaded mathematical attire that plays a fundamental role in the Ndebele nation.

6.3.4 Mathematical artefacts used in AmaNdebele weddings

During a Ndebele wedding called *idwendwe nobukhazi*, AmaNdebele women adorn themselves with beaded attires that symbolise their status and level in the community. On the wedding day, *itjorholo* is worn by a young bride or newly wedded woman. During ritual ceremonies, she normally wears a simple one and a decorated one worn

by omen. It is a rectangular shaped apron on the front, cut by a skilled cowhide. It usually has a width of between 32cm and 35cm, depending on the body size of the wearer, and in some cases even more. A seam around 10 cm folding downward is the top portion around the hip. On each side, at the top corner, it is this seam that has tight straps whereby the *itjorholo* is tightly strapped around the waist. It drops from the waist down to just below the knees. In five rounded flaps, the bottom portion ends.

Also, the *amaphotho* is an adult wear for women. The name still appears in plural form and "*iphotho*" is never used to describe this outfit in singular form. *Amaphotho*'s wearing is representative of the status of a married woman (see figure 15). This outfit is created in form, appearance and all much the same as i*tjorholo*. At the bottom end, the only difference is noticed. There are only two panels in the *amaphotho* apron, one on each bottom side of the apron matching the five *itjorholo* flaps in form. A row of beaded fringes is in between the panels, giving the amaphotho an elegant finish.

Figure 6. 15: married women *wearing* amaphotho *during a ceremony*

Married Ndebele men wear rectangular *iporiyana* and thin neck hoops during a wedding ceremony. *Iporoyana* is well explained above in this chapter. They may also choose to wear *inaka*, which is a round animal skin to cover the back. *Inaka* is mostly worn when men are fully dressed in their attire. Married men (Figure 6.16) come to

support the groom and are usually separated from unmarried males. They sit in *ebandla,* an honourable place in a homestead.

Figure 6. 16: Married men in/at a wedding wearing circular neck hoops and iimporiyana.

6.3.5 Mathematical artefacts used to celebrate the identity of the AmaNdebele

Each year, AmaNdebele leaders host commemorations with a purpose of revising Ndebele culture and bringing the nation together. In all the ceremonies, people are encouraged to wear their geometric attires according to level and status in the community and celebrate their tradition. Women stand out because of their sophisticated beaded attires (Figure 6.17) while men wear less beads. Married men and Kings wear the rectangular animal skin known as *iporiyana*. The following are commemorations in the Ndundza Ndebele under King Mabhoko III.

Figure 6. 17: AmaNdebele women at different stages wearing geometric beaded attires during commemoration ceremonies.

The King Nyabela commemoration takes place annually on the 18th and 19th December at *erholweni kwaNomtjherhelo*. King Nyabela is known as the freedom fighter who fought Anglo-Boer in protecting his land and his people. The war took 8 months, the Anglo-Boer had to call for back up to win the war. He surrendered because they ran out of food and water. His people were starving, then he decided to stop the war. The event is hosted by the Ndzundza Mabhoko royal house.

The King Ndzundza commemoration takes place on the September, which is heritage month. King Ndzundza is the heir of King Musi of AmaNdebele, he initiated his own nation in KwaSimkhulu near Belfast in Mpumalanga. The event is hosted by the Ndzundza Sokhulumi royal house under King Mkhambi II Mahlangu (6.18).

Figure 6. 18: King Mkhambi II at kwaSimkhulu wearing circular neck hoops

The Prince Senzangakhona James Mahlangu Commemoration takes place in September month annually. Prince SJ is the crown Prince of King Mabusabesala I Mabhoko II David Mahlangu. Prince SJ was a freedom fighter who fought against the apartheid system, he refused to accept the independence government system that was meant to divide and rule the black nations. He served under President Nelson Mandela. The event is hosted by the Ndzundza Mabusa royal house under King Mabusa Mahlangu (See Figure 6.19), the National Chairperson of the Traditional House.

Figure 6. 19: King Mabusa Mahlangu wearing neck circular hoops and *iporiyana*

The King Fene Commemoration takes place annually, in the month of September. King Fene ruled AmaNdebele kaNdzundza after King Nyabela and during the Anglo-Boer war, the AmaNdebele lost their land, cattles and were subsequently scattered all over the Transvaal for free, slave labor to members of the Anglo-Boer soldiers. The event is hosted by the Ndzundza Fene royal house under iKosekulu Vimbi William Fene III Mahlangu (see figure 6.20), who's serving in the Mpumalanga Provincial Traditional House.

Figure 6. 20: King Vimbi Mahlangu in the middle with two royal men wearing circular neck hoops and *iimporiyana* (plural).

The commemoration of ikosi uMaphila – Son of Gadatjha of SoKhulumi happens every first week of November at koNosrede (Middleburg behind Komati Power Station). It is hosted by the Ndzundza Maphila Traditional Council. Prince Maphila, I relocated with a section of amaNdzundza to the areas around Hendrina, Middleburg and Witbank after the war between amaNdzundza and the ZAR government of Paul Kruger in the year 1883. It is led by King Maphila II Mahlangu (see Figure 6.21).

Figure 6. 21: King Maphila II Mahlangu wearing circular neck hoops

The commemoration of ikosi uMgwayana, Son of King Magodongo is hosted in: Esibilo (Bethal) or Secunda by Ndzundza SoThinabantuTraditional Council. King SoMphutjhelwa Mahlangu (see Figure 6.22) leads it. Prince Mgwayana relocated with a section of amaNdzundza to the areas around Bethal, Secunda, Louis Trichard, Davel and Morgenzon after the war between amaNdzundza and the ZAR government of Paul Kruger in the year 1883.

Figure 6. 22: King SoMphutjhelwa Mahlangu wearing circular neck hoops, rectangular animal skin called *iporiyana* and a circular animal skin for the upper back called *inaka*

The commemoration of Regent Phaswana – Son of King Mahlangu (SoMakhawula Family) every September in Kwamhlanga, Mpumalanga. It hosted by the Ndzundza SoMakhawula Traditional Council King Phaswana is remembered for his leadership skills and work towards bringing the Ndebele nation together. He is one of the leaders who fought for land and the survival of the Ndebele nation. Regent King Phaswana ruled between the years 1745–1756.This commemoration is held by King SoMakhawula Mahlangu.

Figure 6. 23: Traditional leaders wearing neck and waist hoops at King Phaswana commemoration.

6.3.6 Cultural identity from the AmaNdebele mathematical artefacts observation overview.

Below are the results obtained from the observation of mathematical ideas and concepts in men and women's traditional attires. It also focuses on events where the attires are worn and the status of individuals. The first table shows results from women's attires and the second table provides results from the men's attires.

Table 6. 2: Mathematical attires worn by women during ritual ceremonies

Type of attire during ceremonies	**Level and status**	**Age**	**Term in IsiNdebele language**

1. Small beaded apron with tassels at the bottom that comes at the front (irhabi)	Infant	Birth to 3 years	Umntazanyana
1. Bigger apron with tassels at the bottom (irhabi) 2. She wears a smaller skin skirt at her lower back (ibhayana)	A young girl who can independently do chores	4- 12 years of age	Umntazana
1. Bigger apron with detailed colourful designed and tassels at the bottom (irhabi). 2. She wears a bigger skin skirt at her lower back (ibhayana)	A young girl who is in the early teenage years and can do extensive domestic tasks. She is getting prepared to be initiated	12- 13 years of age	Itlawana
1. Beaded apron with sophisticated colours and designed for maidens (iphephethu). 2. She also wears circular hoops for arms and legs (iinrholwani). 3. She is introduced to a back skin skirt known as isithimba 4. She also wears tassels at the lower back which a place underneath the skin skirt.	A girl who is already initiated and prepared to enter womanhood. Some of the girls in this level participate in others initiation until early 20s while they are still not yet married.	14-18 years of age	Ifotini / ithelerina
1.Beaded apron with sophisticated colours and	A young woman who recently got married.	19 -30 years of age	Umakoti/ Umalukazana

designs for brides (itjorholo) 2. She also wears circular hoops for arms and legs (iinrholwani) 3. She wears neck whoops called *ijuba (*thick and blue in colour*) nobukhobe (thin and pink in colour)*, as a symbol that she is married. 4. The lower back skin skirt (isithimba) is longer at this stage	This woman resides with her inlaws.		
1.Beaded apron with sophisticated colours and designs for matured women (amaphotho), 2. She wears copper and brass rings (idzila) on her ankles, armlets, and neck. 3. She also wears the lower back skirt (isithimba)	Adult married woman with children who are ready for initiation. She also resides in her own house	31+49 years of age	Mfazi/ iqhakazana
Same as the above	An adult woman who is considered as a senior and custodian of knowledge. She is a leader of ritual ceremonies and highly respected in the community	50+	Isalukazana

The above results presented in the table interlink with the data that was presented in this chapter. The results show that Ndebele attires are worn according to levels and

status during ritual ceremonies. Furthermore, the attires and colours advance according to levels. It is therefore taboo for a maiden to wear an attire meant for a married woman. Ndebele people understand and respect customary laws regarding dress codes.

Table 6. 3: Mathematical attires worn by men during ritual ceremonies

Type of attire during ceremonies	**Level and status**	**Age**	**Term in IsiNdebele language**
1.Rectangular small front apron made of animal skin (Ibhetjha)	Infant	Birth- 3	Umsanyana
1.Rectangular bigger apron made of animal skin covering the front and back (Ibhetjha)	Boy who can do small tasks	4-12 years old	Umsana
1. Same as the as the above except that at this age, he receives circular bangles from his first girlfriend. The bangles are symbol of love. 2. The boy also receives the rectangular piece of artwork that looks like a baby bib , made up of beads	A young boy who is in the early teenage years and can do extensive tasks such as hunting. He is getting prepared to be initiated	13-15 years of age	Msegwabo
1.A new initiate wears a beaded circular headband on his clean-shaven head. This headband is about 1 - 2cm wide. It is tailored to fit the head Tightly 2. On the neck, the initiate wears a circular beaded necklace (*irasu*). It	At this age, a boy undergoes the process on initiation, and he is welcomed into young manhood.	16-18 years of age	Isokana

is more or less 2 cm in diameter, and it is not built to fit tightly but usually hang loosely on the neck for easy removal. 3. On his upper body the initiate wears a batch of white beads crossing them on both his shoulders to form an x-sign on his chest and at the back known in Ndebele as izipha (plural) and isipha (singular). 4. On the waist the initiate again puts on 2 - 3 whoops. The arms are also dressed up in small hoops (iinrholwani), two to five on each Biceps. 5. He also wears an triangular underwear made of cow skin (Sincw adi/ istitirimba)			
1.He wears rectangular animal skin shaped to cover the chest often with tassel ending at the bottom called iporiyana 2.He also wears a round shape to cover his upper back (inaka)	A married man. He also has children who are undergoing initiation	19-49 years of age	Ubaba

Same as the above	He is a senior and knowledge custodian. He is well respected within the community. He also takes lead in ritual ceremonies such as initiation for boys.	50+	Iqhegu

The table above stated how men wear during ceremonies. The results show that unlike women, men do not wear many beadworks. Rather, their attires are made mostly from animal skins which are tailored in a manner that they reflect geometric shapes (mostly triangles and rectangles). This proves that mathematical ideas and concepts in the Ndebele culture are not limited to mural art, beadwork, and architecture.

6.4 Discussion

6.4.1 Introduction

The objective of exploring the cultural identity from the AmaNdebele mathematical artefacts was achieved in this chapter. On this section, the chapter discusses the results obtained and look at similar studies on the same topic.

6.4.1.1 AmaNdebele artefacts serve as cultural identity and expression

The Ndebele mathematical artefacts are used for cultural expression and identity which is mostly shown during ritual ceremonies. Such includes weddings, and male and female initiation processes. Before these ceremonies, preparations are made by custodians of the artefacts who are women. They paint walls using geometric designs and construct beaded attires. Furthermore, women adorn themselves in beaded attires during ritual ceremonies as compared to men. Their attires show detail designs that showcase their skills and bride as Ndebele women.

Levy (1990) who conducted similar studies on Ndebele beadwork stated that beadwork has a long history of engagement with the AmaNdebele community as a key conduit for the formation of specific cultural meanings of Ndebele identity. The historically persistent character of beading has imparted a distinct cultural identity upon the AmaNdebele community (Smuts and Mahlangu, 2015; Levy, 1990). In keeping with what Smuts, Mahlangu (2015) and Levy (1990) discovered about the production and utilization of beadwork to evoke conceptions of Ndebele identity, the study shares the same sentiments that beadwork produced key conceptions into the

processes of Ndebele identity in its different incarnations. According to Nettleton (2014), women are both consciously and unconsciously responsible for maintaining cultural identity. This, according to the conclusions of this study, was simply because they were considered to be chosen by gods to undertake such responsibility. As a result, AmaNdebele women continue to take satisfaction in displaying their Ndebele identity through artefacts until now. As Schneider (1986:64) also explained that "through her painting the artist is saying that she is a good Ndebele wife who keeps a proper and well-decorated home," taking pride in being a custodian of artefacts and expressing her culture identity.

Davison (1985) has said unequivocally that the Ndebele people kept their art after the Mabhoko War in 1882 because it was the cornerstone of their identity. In his own words, he stated:

> They uprooted and relocated the Ndebele to different parts of Southern Africa. However, the Ndebele maintained a strong group consciousness, and art became one way in which they asserted their identity. They painted their homes with distinct patterns and wore beaded clothing and ornaments as part of everyday dress. Thus, the Ndebele proclaimed their cultural identity no matter where they were. (Davison, 1985: 19).

The fact that women are the exclusive handlers of beads in Ndebele, according to Whooper (1988: 3), is an added mark for women. She makes the following argument...

> It is women who have been the practitioners of the artistic forms which are such striking Ndebele cultural markers. In beadwork and wall painting women have an outlet for the expression of their experience of the world, of their aspirations, and of their identity as individuals and as part of a group. (Whooper, 1988: 3).

Nettleton (2014) who conducted a study about women, Beadwork and Bodies discovered that the artistic work women made was for identity purposes. He quoted one of his participant who confirmed his observation and stated that "Hlabisa from those from Nongoma, Msinga or the Ngwane areas, speaks to the ways in which women constructed forms of beadwork to perform the particular task of identity marking…" (Nettleton, 2014:341).

On the other side, Zungu (2000) discovered in her PhD study that beadwork is as essential as a form of identity since it allows individuals to distinguish themselves from other clans. Each clan in this area has its distinct beaded style that separates them from one another. Mashiyane (2006) backs up this claim, noting that in African culture, beading served as a means of identifying distinct tribes and the status of the bead/costume wearer.

Rich's detailed study of Ndebele architecture (1984) emphasizes the complex patterns, sophisticated geometric patterns, and the impact of Western designs, which can be seen in photographs of planes and light bulbs. Similarly, Powell (1995: 60) tells us “in many cases the new imagery included on walls was a depiction of things seen in the suburban homes when women were, and still are, employed as domestic workers…” Rich (1984) and Powell (1995) believe that contemporary technology has a significant impact on Southern Ndebele architecture and wall murals. This study argues that there is indeed an influence of contemporary technology in the Ndebele modern art where women decided to be innovative. However, the cultural shapes that date back to less than the 16th century are those with meaning and serve as culture identity which this study has discussed.

6.4.1.2 Ndebele cultural identity celebrated during annual commemorations

Annually, the AmaNdebele celebrate their identity through commemorations and ritual ceremonies. It is during these celebrations where they adorn themselves in their cultural attires. Women dominate with their beaded geometric attires and take pride of being Ndebele. Men continue to wear less beads and animal skins cut and curved in a way that reflects certain geometric shapes. All of this is done to honour the Ndebele heritage and showcase what is perceived as an identity by AmaNdebele.

Marschall's (2004) work provides fairinsights into legacy as a territory where "commemoration, memorials, museums, renaming of cities, buildings, and streets, and national festivals" mobilize consciousness of belonging Marschall (2004:96). Cultural identity is portrayed in Zulu, Ndebele, and Xhosa-speaking people's beadwork, according to Hamalwa (2012). South African beads, from a sociological standpoint, instil a sense of ethnic identity since they represent a chain of traditions to which people relate in a social setting. Beadwork, according to Dubin (1987), is instructive. The mix of constructing the parts, as well as the selection of individual beads, serve

to define a group's concept (Dubin, 1987:47). As a result, the distinctive patterns and motifs communicate a sense of cultural and ethnic togetherness within a specific ethnic community.

As per Smith (2006) and other scholars, tangible and intangible cultural heritage can provide local residents a sense of belonging, i.e. a sense of place (Barkan & Bush, 2003). “A heritage site may thus reflect or substitute for a sense of identity and belonging for specific persons or groups” (Smith, 2006: 77). This tangible and intangible history is also critical for a country's national identity, since it contributes to local residents' historical awareness of a region or country (Lyons, 2002). Heritage, according to Smith (2006), is a practice that involves a variety of behaviors such as “remembering, commemorating, sharing and passing on information and experiences, asserting and expressing identity, and social and cultural values and meaning “(Smith, 2006: 83).

For AmaNdebele, annual commemoration and ritual ceremonies serve as a way to preserve culture. By expressing culture frequently, many people are able to embrace who they are and have the drive to continue doing so, produce and buy AmaNdebele artefacts. The IKS policy of (2004) which has also been mentioned in this study supports the development of African heritage and local strategies used to preserve and promote Indigenous knowledge. It is therefore crucial for Ndebele women to continue making crafts and also for the people to express who they are by embracing their artefacts which form an integral part of their identity.

Concluding remarks

The outcomes of the cultural identity portrayed through AmaNdebele mathematical creations were presented in this chapter. The chapter elucidates how AmaNdebele artefacts are utilized in the culture. It also included information on the clothing used by women and men during commemorations and ritual ceremonies. It argued that annual celebrations hosted by the AmaNdebele are a way of preserving culture and expressing their identity and that is when Ndebele geometric artefacts are visible and utilized. The following chapter presents results on preservation and protection of AmaNdebele mathematical artefacts.

CHAPTER 7: EXPLORING THE PRESERVATION AND PROTECTION OF AMANDEBELE MATHEMATICAL ARTEFACTS

7.1 Introduction

In its Congressional Presentation Report for the fiscal year 2000, the Government of the Republic of South Africa (RSA) indicated that it is committed to liberal economics, but mounting pressure to produce jobs could derail these changes and undermine the government's legitimacy. Intellectual property laws that support the entrepreneurial spirit, people who start and run businesses, and the creative endeavours of authors, artists, and others by protecting their intellectual property rights can help the South African government achieve its economic reform goals (Foley & O'Connor, 2013).

The issue of intellectual property rights and its relevance to AmaNdebele entrepreneurial artists like Esther Mahlangu, recognized as one of South Africa's most important traditional Ndebele artists, has become more relevant than ever before in an ever-expanding global market. The proper functioning of intellectual property can contribute significantly to long-term development. After all, one of the primary functions of intellectual property laws is to boost the economy. (Bhuda, 2019) stated that a suitable setting is required for the enterprising craft artist to thrive. Because the entrepreneur exhibits a propensity for invention, risk-taking, and the ability to seek capital, new markets, products, and technology, entrepreneurship is a vital aspect of economic progress (Boyd, 2017).

One measure for facilitating economic relations between corporate entities on a national and worldwide level is the protection and enforcement of intellectual property rights laws. Craft production, for both economic and cultural reasons, requires legal protection from exploitation (Foley & O'Connor, 2013). Maintaining adequate intellectual property protection serves as a signal to the worldwide business community that a country wants to do business there. To this purpose, Ndebele arts would be conserved, and a viable commerce economy would be established. The research investigates how the AmaNdebele mathematical artefacts have been conserved and protected. It is guided by the following research question: How has the AmaNdebele mathematical artefacts preserved and protected?

7.2 Methodology

7.2.1 Research design

An exploratory research design was used for the study whereby the researcher wanted to explore the indigenous methods used to protect and preserve the AmaNdebele mathematical artefacts. The researcher has also used an investigative research design to investigate existing documents which protect indigenous Knowledge Systems in South Africa.

7.2.2 Target population

The target population for this chapter were eight women from the KwaMsiza Mabhoko community. As was indicated during data collection, women are the main custodians of the AmaNdebele artefacts, and they participate more than men in the protection of the artefacts. They were also selected to be participants based on their wisdom of artefact protection and years of experience.

7.2.3 Sampling size and sampling procedure

The sampling size consisted of eight women with knowledge, experience, and expertise. Thus, a purposive sampling was used.

7.2.4 Data collection strategies

7.2.4.1 Tools

In-depth (face to face) interviews were used as a guide to collect data from the participants (see appendix 4). Face-to-face interviews enabled the interviewer to directly communicate with the participants in accordance with the prepared questions. The in-depth questions allowed the researcher to use open-ended questions to elicit detailed responses and explanations from the participants. The researcher had the opportunity to build a connection with the participant, allowing them to feel at ease. As a result, participants provided honest comments, and their facial expressions and body language were monitored. Such cues resulted in a large volume of data for the study.

7.2.4.2 Methods

First, in-depth interviews were conducted with experts who are elderly women (see Figure 7.1) in their environment, where they were sharing knowledge with the researchers. The study process was explained to the participants before interviews began. The interviews were more of a guided conversation (open ended questioning) rather than an answer session.

Second, a qualitative document analysis was utilized to examine legal documents pertaining to the protection of AmaNdebele crafts and other indigenous crafts and works. The researcher carried out desk research in order to identify documents which were aligned with this study. As a technique of triangulation, qualitative document analysis was utilized in conjunction with other qualitative research approaches (Denzin, 2012; Wood et al., 2020). For this method, documents that have been analyzed are:

a) The protection of artistic work through The South African Copyright Act of 1965
b) Copyright Act, No. 98 of 1978
c) South African Designs Act No. 195 of 1993
d) Congressional Presentation Report for fiscal year 2000
e) The Indigenous Knowledge Systems (IKS) Policy of 2004
f) South Africa's Intellectual Property Laws Amendment Act, 2013 (the IPLA Act)
g) Trademark amendment Act No. 28 of 2013
h) Indigenous Knowledge Systems Act of 2019
i) South African Intellectual Property Policy Act (IPP) of 2018
j) The National Policy on Living Heritage in South Africa 2009

Documents have been sourced from the South African government archives and data bases from different departments that are accessible to the public. The documents above were selected because they are aligned with the study and speak to the objective of this chapter. They discuss in-depth the protection, preservation, and utilization of indigenous artistic works for wealth creation purposes hence the reason they were appropriate for this study. Qualitative document analysis included classifying content into themes in the same way that focus group or interview transcripts were evaluated (Wood et al., 2020).

Figure 7. 1: Some of the participants of the study

7.2.5 Data analysis

A thematic analysis was used to analyse data from open-ended questions. First, in-depth face-to-face interviews were transcribed from voice recordings and translated from the language of IsiNdebele to English. The data was analyzed manually, and themes were identified (Braun & Clarke, 2014). The researcher read through data files to verify the consistency before gaps were recognized. When gaps were discovered, the researcher had to review the area of the study to obtain clarification for trustworthiness (Lincoln & Guba, 1986).

7.3 Results

7.3.1 Introduction

The results of this chapter are presented into sections. First, the themes generated from thematic analysis and the results generated from content analysis. From thematic analysis, themes that were identified are as follows: knowledge about Mathematical artefacts protected and preserved using local indigenous methods; selling of mathematical artefacts as a way of preserving and protecting knowledge; attracting tourists by using mathematical artefacts; including of Ndebele indigenous knowledge in the school curriculum.

7.4 Knowledge about Mathematical artefacts protected and preserved using local indigenous methods

According to participants of this study, there are local methods which were identified to preserve and protect the knowledge of mathematical artefacts within the AmaNdebele society. This knowledge can be shared on different platforms that have been selected and chosen by the Ndebele traditional authority. According to participant 1, ceremonies influence the preservation and protection of this knowledge as women with experienced are obliged to teach those who know nothing. Further, mothers can randomly teach their daughters at home using different process.

To avoid the repetition of results, the focus of this study limits itself to methods of knowledge preservation and protection because the purposes, processes, and setting of persevering and protecting this knowledge were reported in the master's degree of researcher under the theme: "Mechanisms of ethnomathematical knowledge transmission amongst Ndebele women" (Bhuda, 2019: 124).

7.4.1 Knowledge preserved and protected orally

According to the findings of this study, mothers can share knowledge about mathematical artefacts with young girls orally, specifically in the evening when cooking outside in the place called *eZiko*. This is where most stories and ideas are shared between mother and daughter. The mother during this time can share the history of the mathematical artefacts with her daughter and why they are part of AmaNdebele identity. The daughter is allowed to respond and ask questions. This is where passion to preserve this knowledge develops. The daughter then continues to be interested in this knowledge and asks for more information. According to the age and experience of the daughter, the mother will continue to share advanced knowledge with her child. In her own words, participant 3 who has taught her daughter to do beadwork stated the following:

> *"Wami umntazana ngamfundisa ngobukghwari bamaNdebele nangipheka naye ngaphandle emlilweni, ngitjho eZiko kazi. Ngalesi sikhathi, kula bengimdembela khona kabanzi ngamasiko wethu nokuthi thina AmaNdebele sibobani. Ilwazi engalimunya kumma ongibelethako kuqakathekile bonyana lidluliselwe ebantwaneni bami Ngiyoke indlela yokubulunga isikhethu le."* I have thought my daughter about Ndebele

traditions during the times we spent together when cooking using fire outside in eZiko. In that time, I was sharing knowledge with her about the AmaNdebele culture and heritage. This is the indigenous knowledge I have obtained from my own mother, and it is important that I transfer it to the next generation in order to preserve this knowledge.

Based on the response of the participant above, it is clear that oral knowledge transmission plays a vital role in the protection and preservation of AmaNdebele mathematical artefacts. What the respondent also provided the researcher with, is the important time spent together by the mother and daughter in eZiko, because that is when knowledge is shared.

7.4.2 Knowledge protected and preserved through observation

When mothers believe that their daughters are ready to acquire knowledge, they allow them to observe the process of bead working and painting. This happens for a certain period until the daughter is ready to do what she has been taught on her own. The daughter depending on her age and status in her community, does these practices. For instance, a girl who is not yet a maiden is not allowed to do beadwork attire for girls who have undergone initiation process. Girls who are maidens do not sew beaded attires for married women until their married themselves. Women with no initiated daughters and sons do not do any beadwork until their children have undergone such practices.

As far as mural art is concerned, girls who are not yet married can just only practice in their parents' houses. They do so until they're married then paint their first hut homes called *amaqathana* (plural) and *iqathana* (singular). They may also paint the homestead during the initiation period, only if their children or close relatives are being initiated. This therefore proves that there are laws and taboos surrounding AmaNdebele mathematical artefacts which participant 3 explained as follows:

> *Umuntu ufundiswa ngokuya ngesigaba sakhe ngombana thina simaNdebele sinemithetho. Akukghonakali bonyana umma afundise umntwana izinto ekufuze zifundwe mfazi osemendweni. Awa ngiyala mntazana! Lokho zabe kumhlolo. Angayokuhlawuliswa nekosini dani.* A person is taught according to her level and status according to the laws of the AmaNdebele. It is

> impossible for a mother to teach her young daughter things that should be taught to married women. I refuse my girl! That will be abomination. Traditional leadership will even fine the mother.

Furthermore, during ritual ceremonies, women are allowed to observe how inspiration is drawn from the sophisticated beadwork and mural art. Ritual ceremonies are an opportunity for women to learn and create networks with each other in order to privately communicate and give each other some tips.

7.4.3 through participation

After the stage of observing experts, AmaNdebele females imitate what has been thought to them. Perfecting their skills requires years of training and patience. Some get frustrated during the process while some become resilient. Once one excels in making art, it becomes easier to advance when time goes on because they already have mastered the basics. Participation is seen more like an exam because students participate in the presence of the experts and in their absence also. The skills of the learners are tested and examined during the time they participate and apply the knowledge which they have acquired. Participant 3 argued that “when you participate in somethings, you clearly do not forget.” This she mentioned after stating that it is important to show interest and resilient during the time of participating because that is a key to learning and mastering the art.

7.5 Selling of mathematical artefacts as a way of preserving and protecting knowledge

In the KwaMsiza Mabhoko community, women sell their mathematical artefacts in local markets, the Pretoria Central Business District (CBD) and in their household. According to the participants, because mathematical artefacts play a vital role in economic development, they are obliged to continue practicing this art. Using mathematical artefacts as an economic tool is another way of promoting and preserving the Ndebele culture. The AmaNdebele women sell painted artefacts and beaded artefacts (see figure 7.2) which fit into modern times. There are women who do this as the work daily while others do this as their second interest after their daily jobs.

These mathematical artefacts and custodians, work with their children to promote their businesses even using social media. Therefore, young people also gain interest of preserving this culture because their contributions matter. AmaNdebele women have also moved with times, whereby they modify their artefacts using modern styles. These are artefacts sold to people and are not used for ritual ceremonies or other important cultural purposes. For instance, Ndebele artists imitate/copy circular copper rings worn by married women and sell them. Instead of using copper or brass, they use plastic materials that they buy in bulk and has no cultural significance. The cultural rings are well kept and worn as according to the customary laws of the AmaNdebele. Regarding the use of mathematical knowledge for commercial purposes, participant 2 expressed the following:

> *"Abantu siyabathengisela izinto esizigwalako nesiziphothelako. Abathengako ngilaba abathanda ukubabahle ngombanyana bayazirhabisa. Zibakhona ke zesintu, ngikhuluma ngezinto eziphothelweko khulu khulu. Lezo zithengwa maNdebele enza umnnyanya kanye nezinye izinto eziphathelene namasiko. Lokho akutjho bonyana abanye abantu bangaphandle abavezi itjisakalo yokuzithenga, bona bayayiveza. Kodwana, AmaNdebele ngombana azi umthetho, athenga ivunulo yesikhethu ngehloso. Akusikanengi bona bayithenge ngombana yisikopilo lethu, banengi abantu bengubo abaphothelako yeke, sithola imali khulu kulaba bangaphandle. Nokusebenza nabentwana bethu kuqakathekile ngombana bazibona bayingcenye yesikhethu begodu nendima abayidlalako bayayithabela. Ngiyoke indlela yokubulunga ubukghwari bamaNdebele le ngombana nakubhubha thina, ngibo abazakusala. Kwazibani, mhlambe bangenza ngcono kunathi bathole ezinye iindlela zokubulunga ilwazi njengawe nje mntazanami. Naso indlela uyitholile naBhuda, syathokoza njakazana kamawela."* We sell painted and beaded artefacts to people, especially those who like fashion and style. We also do have traditional artefacts which are bought the AmaNdebele for ritual and cultural purposes. That does not mean that people who are not Ndebele do not show any interests in buying cultural artefacts, especially beadwork. Infect, outsiders do buy it but to the AmaNdebele, it has cultural significance and used according to customary laws. However, we hardly get orders from the

AmaNdebele because this is cultural practice, and most AmaNdebele females are experts of this art. Therefore, we benefit more from people who are not Ndebele. Working with our children is important because they see themselves as part of the culture. This is a strategy of protecting and preserving this knowledge because when we die, they will carry on with the knowledge. Who knows, maybe they will do better that we have done and find more ways to protect this knowledge, just as you did my daughter (referring to the researcher)? You have found your way *naBhuda*, we are proud of you *Njakazana Kamawela* (praising the researcher using her clan names).

The above excerpt was a widespread view among the participants who take pride in preserving and protecting their culture through commercialization and the involvement of the youth. Most of the data collected from participants casted their sentiments in ways that gestured towards passion to preserve and protect Ndebele knowledge while they also benefit financially from it. In order for their strategy to work, they need to keep up with modern styles and use digital platforms to attract customers that are far from their geographical area. The AmaNdebele mathematical artefacts therefore continue to survive because of the strategies put in place by custodians.

A: Modern painted artefacts reflecting mathematical ideas and concepts B: Modern beadwork reflecting mathematical ideas and concepts

Figure 7. 2: Beaded and painted artefacts for commercial purposes.

7.6 Preserving AmaNdebele mathematical artefacts through tourism

As women have been selling their art to the tourist public since at least the 1950s, if not earlier, the commercial demand for Ndebele beadwork is not recent. The business has grown significantly over the last few years. The women in the KwaMsiza Mabhoko community have over the years attracted tourists from all over. They have been able to sell their artefacts and generated income from their skills. The village was even declared a national heritage site and a tourism destination by the South African government in 2002. Participant 3 stated that there was a huge celebration amongst the people when this village was declared a national heritage site because it shows that the government recognizes their skills and culture.

Making the village, a heritage site (see Figure 7.3) was a way of preserving the indigenous knowledge of the AmaNdebele. People who have visited the community have written and published about the experiences they have heard when they were surrounded by the AmaNdebele. The information that has been published about the community is a tool of culture preservation and promotion. However, majority of participants have raised concerns regarding tourism and government in the past few years. They have explained to the researcher that the government has gradually neglected the place and buildings such as the BnB and community hall (see Figure 7.4) that are no longer monitored and maintained. They have further stated that their management office has been shut down and they must promote themselves individually. Those with good finances can renew their homes annually not only for cultural practices but also for tourism attraction (see figure 7.5). Those with no financial stability, remain with houses which are not in good state and have old paint (see figure 7.6) Therefore, this means that there is less tourism attraction, less written work over the few years about this place and only those who can afford, renew paintings in their homesteads.

Sharing her concerns with the researcher, participant 6 stated the following:

> *“Thina urhulumende wangapha ngetlhagwini tjingalanga, akasitjheji simaNdebele. Indawo le ayisatlhogonyelwa njengekuthomeni. Le bekuyindawo ekarisako, ethandwa babantu bangaphandle kodwana ngokuya kwesikhathi, izinto zatjhuguluka. Sikhuluma nje, ngithi sisitjhaba*

esizitlhogomelela lendawo. Nawunganazo iinthoro kuhle, usalela ngaphandle ngombana nakufika amaphandle la, akhetha imizi ekarisako bese kuthi lowakho, ungatjhejwa nokutjhejwa ngombanyana uluphele. Äbantu abanengi abahlala lapha sebayadonda ukubulunga isikhethu ngombana abananseteenziswa begodu abasekelwa. Ngathana singe Pumalanga, ngabe amakhosi wekhethu akghona ukufaka isandla. Kodwana ngombana kunepolitiki, kubabudisi bonyana baphoselelabo lobubodlhana esikhathini esinengi." We do not get any assistance from the North-West province government as the AmaNdebele. This place is no longer maintained compared to before. This was a tourist attraction place but when time passed by things started to change. As we are speaking, the community has decided to promote itself without any assistance. However, when you do not have financial stability and ways to maintain your art, you are left behind because when tourists visit this place, they only focus on well-maintained artefacts. Most people who live here are becoming less interested in preserving our culture because the lack necessary support and materials. If we were situated in Mpumalanga, our traditional leadership would be assisting us. However, because of politics, their suggestions in this province are not considered.

The response by the participants raised concerns about the future of their environment as a home and heritage site. It further shows that in a short period of time, the people will eventually stop preserving their artefacts through tourism because they feel like the government has abanded them. Even though they have indicated that they have a good relationship with the *Ndzundza* traditional leadership Mpumalanga and take orders from the King, challenges still rise because of their geographical area and politics play a vital role when it comes to such. Other concerns of the participants were that since they have been neglected by the government, there have been no outreach programs held with the purpose of preserving culture. No government officials have visited them in the past 10 years to see what exactly they are lacking on. Therefore, reviving their dwellings and economy at this state soley depends on them.

Figure 7. 3: Opening of the Kwamsiza Mabhoko cultural village/ community in 2002

Figure 7. 4: current state of KwaMsiza Mabhoko cultural community hall

Figure 7. 5: A well maintained Ndebele painted house

Figure 7. 6: An old painted house that is falling apart

7.7 Inclusion of Ndebele indigenous knowledge in the school curriculum

AmaNdebele in general are concerned about their knowledge fading away. Therefore, they believe that it could be saved through education. When asking participants questions, most of them proposed for the inclusion of the Ndebele indigenous Knowledge to be part of the curriculum. The arguments which were made are about Ndebele children learning about their own knowledge in schools. They have further stated that, they are not familiar with what has been taught to their children in schools

and encounter problems because they cannot relate with the content taught. One of the participants even asked the researcher the following questions:

> *"Kanti kubayini abentwana bethu bangafundi ngobukghwari babo ngenkolweni? Kanti akusiyo ifundo le na? Wena njengomuntu ofunda ngesikhethu, uthomenini ngombana enkolweni into le oyenzako ayikho*?" Why is it that our children do not learn about our culture? Is it not education? As a person who is currently learning about our culture, when did you start because this is not done in schools?

The above are critical questions raised by a concerned parent and culture custodian. Indeed, there is a concern of the Ndebele knowledge not being included in schools. In addition, stating more concerns, another participant argued that:

> *"Qala musi, isikhethu lesi nasingangena ngeenkolweni, sizokubulungeka bego neenzukulwani zethu zizolithola ilwazi leli zilimumathe. Mntwanethu, Ndebele lakwethu, sibawa usilwelwe simaNdebele ngombana thina indlela njengabogogo nabantu abadala yokuzikhulumela asiyazi. Siyabawa bonyana usirhelebhe ngombanyana Isikhethu singabulungwa begodu sivikelwe yifundo. Sitlhoga kwaphela abarholiphambili abazosijamela epini le."* If our culture can be incorporated in schools, then there is a great chance of it being protected and preserved. The younger generation will also be able to access the knowledge. Our child, our fellow Ndebele, please fight for our identity because we are unable to as old women and elders. Please help us because our culture can be preserved through education. What we lack of is leadership and people who are willing to stand in the front.

The researcher kept receiving requests from participants to take a stand and protect this knowledge. They kept asking her to be their leader despite her age. The researcher then disclosed her current works, which aims to protect the isiNdebele Indigenous Knowledge. The researcher made the participants aware about the IsiNdebele book she has written entitled: *umgwalo wobukghwari baka Kwekwezi* and translated, also written in English entitled: *Kwekwezi's cultural mural art*. This is a children's storybook (see figure 7.7) which focuses on Ndebele mural art. *Qala kukunje utlole incwadi ngomgwalo wesikhethu*

mntazana. Lokho kutjengisa irhuluphelo onalo ngesi Ndebele bonyana sifundwe". Look now, you have written a book about mural art. That shows the passion you have about the Ndebele Indigenous knowledge to be learned, a participant said.

The positive feedback and reactions of the participants towards the book of the researcher show how much passion they have for education. Even though they are indigenously educated and not formally educated, their wisdom was preserved through the children storybook, and the younger generation enjoys reading the book (see figure 7.8).

A: Children' story books written by the researcher B: The researcher holding her book.

Figure 7. 7: The IsiNdebele children's' story book written by the researcher

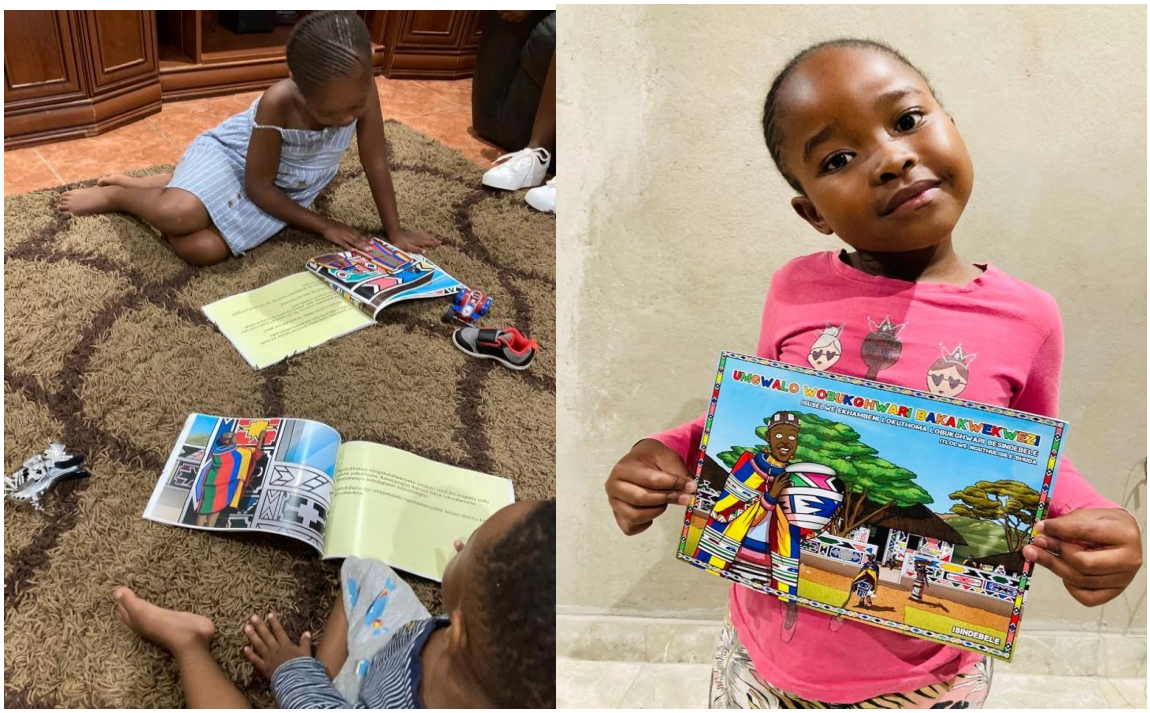


Figure 7. 8: Children reading a children storybook written by the researcher

7.8 Results from the qualitative document analysis

7.8.1 Introduction

Qualitative document analysis was carried out using the following processes: (1) ready materials, (2) extract data, (3) analyse data and (4) distil the findings. Themes from qualitative documents analysis were presented as follows: The protection of artistic work through The South African Copyright Act of 1965; The concept of moral rights copyright law in South Africa; The registration of indigenous designs; The importance of intellectual property rights and entrepreneurship in South Africa; The establishment of the Indigenous Knowledge Systems (IKS) policy of 2004; Promoting living heritage which was side-lined due to historical imbalances; Trademark of Indigenous terms and expressions; Protecting indigenous cultural expressions through the database; Effective protection of Intellectual Property Rights through the South African Intellectual Property Policy Act (IPP) of 2018; The protection, promotion and development of the Indigenous Knowledge Systems.

7.8.2 The protection of artistic work through The South African Copyright Act of 1965

The South African Copyright Act (1965) defines "artistic work" as "paintings, sculptures, drawings, engravings, and photographs, regardless of aesthetic quality." Also, included are works of architecture, such as buildings or models of buildings, as

well as works of aesthetic workmanship and technical craftsmanship. The following acts are prohibited by the copyright in an artistic work, according to Section 4(4) of the Copyright Act of 1965: reproducing the work in any material form, publishing the work, including the work in a television broadcast, and causing a television or other program that includes the work to be transmitted to subscribers to a diffusion service.

Furthermore, the South African Copyright Act specifies that a literary or artistic work's author/(creator) has copyright in the work only if it is original in character. The term "original" here refers to the fact that the work must come from the author himself and cannot be plagiarized. Only literary, dramatic, musical, and aesthetic works are referred to as "works" in the 1965 Act. The 1965 Copyright Act also specifies that the copyright can only be exercised in respect of two types of works: literary and artistic works. Copyright is expressly provided for in dramatic and musical works, sound recordings, cinematography films, broadcasts, and published editions under the Copyright Act.

In order for copyright to exist in a work, it must not be of a sort that is against public morality. The underlying reason for this condition is that protecting a work that is likely to corrupt any part of society would be against the public interest. Copyright is the exclusive right granted to the author of any original literary or artistic work to duplicate and exploit the work's commercial potential.

The author of the literary or artistic work in question will not always have a copyright. It is also worth noting that artwork generated by authors or painters will not vest in the ‘author' if the artwork is created for the employer while under a contract of service or apprenticeship. Regular employees' work is believed to be owned by their employers' copyright. Employers own all rights to works made within an employee's area of employment unless there is an agreement to the contrary.

7.8.3.1 Limitations and expectations

Fair Dealing

The South African Copyright Act, like most Commonwealth countries with legal systems based on UK law, has a general exception for "fair dealing" with a copyrighted work. The term "dealing" has the same meaning as "use," and it refers to any use of a

work that is "fair" and falls within the section's permissible purposes. In this sense, "fair dealing" in South Africa and "fair usage" in the United States and elsewhere are the same. The main distinction between the US fair use general exception and South Africa's fair dealing privilege is that the latter applies solely to a limited set of uses. The Copyright Act of 1965 permits the use of artistic works for the same purpose, but not under the headings of "fair dealing" or "fair use." It addresses this subject separately, restricting the defence to the reproduction or publication of artistic works that are temporarily on display in (1) a public place; (2) public premises; or (3) a work of architecture.

Revisions to the 1978 Copyright Act relating to "fair use" are generally not seen as favourable to the creators of artistic works. The protection of visual artists under the Copyright Act is problematic. The need that a copyright notice be placed on an object, for example, is judged unattractive. For textual work, such a notice is permissible, but not for visual works of art since aesthetic enjoyment is gained from the visual experience. “Copyright shall be transmissible by assignment, testamentary disposition, or by operation of law as personal or movable property,” according to Section 36(1) of the South African Copyright Act of 1965, subject to the limitations of the section. Both existing and future copyrights can be assigned under the Act. Furthermore, it provides for an entire or partial assignment of copyright, whether present or future.

7.8.3.2 Quotation

Section 12(3) states:

> "The copyright […] shall not be infringed by any quotation therefrom, including any quotation from articles in newspapers or periodicals that are in the form of summaries of any such work: Provided that the quotation shall be compatible with fair practice, that the extent thereof shall not exceed the extent justified by the purpose and that the source shall be mentioned, as well as the name of the author if it appears on the work."

The South African copyright is unique in that it allows for any type of quotation. This is a feature of the "fair use" right in the United States. However, unlike fair

use, the quotation right can only be used to quote a portion of a work, not the entire piece, such as a photograph.

7.8.3.2 Incidental use

Section 15(1) states:

> "15(1) The copyright in an artistic work shall not be infringed by its inclusion in a cinematograph film or a television broadcast or transmission in a diffusion service, if such inclusion is merely by way of background, or incidental, to the principal matters represented in the film, broadcast or transmission."

His right is restricted to capturing "an artistic work" in other works. “Artistic work” is defined in Section 1 of the Act as “(a) paintings, sculptures, drawings, engravings, and photographs; (b) works of architecture, which are either buildings or models of buildings; or (c) works of handicraft [...].”

As a result of the incidental use right, a structure or sculpture in the background of a scene could be filmed. However, music, film, or broadcast material, as well as literary texts, are not included in the definition in section 1. It would not allow the recording of music on the radio, a television program, or even a literary text such as an open book, because these works are not defined as "artistic works." Only if the captured work is "by way of background, or ancillary, to the major matters conveyed" does the right apply. As a result, it appears to allow the capturing of works in the background of a video but not the direct filming of works in public spaces.

7.8.3 The concept of moral rights copyright law in South Africa

A "moral right" in the context of copyright law, on the other hand, is a personal right that attaches to the author and allows the author to receive proper credit when his or her work is utilized, as well as dictating, to some extent, how others handle the author's work. The Copyright Act, No. 98 of 1978 (as modified) (“the Act “) governs copyright law in South Africa, and it is managed by the Companies and Intellectual Property Commission, which is part of the Department of Trade and Industry. Literary works, musical works, artistic works, cinematograph films, sound recordings, program-carrying signals, broadcasts, published editions, and computer programs are among the nine classifications of works eligible for copyright protection under the Act.

Section 20 of the Act establishes a legal obligation to credit an author's work and not to treat it disparagingly, as well as defining a moral right as a protected right that applies to literary, musical, and artistic works, cinematograph films, and computer programs (but not to sound recordings, broadcasts, or published editions) (“work/s”). A moral right is made up of two parts: the claim to paternity and the right to the author's work's integrity. The right to paternity allows the author to claim ownership of the work, but the right to integrity allows the author to object to any distortion, mutilation, or modification of the author's work that would be detrimental to the author's honour or reputation. Even while copyright protects the producers of art, literature, and music, the concept of moral rights is unique from copyright law. By granting artisans a limited monopoly in their creative endeavors, copyright provides them with material and economic incentives.

7.8.4 The registration of indigenous designs

The South African Designs Act No. 195 of 1993 regulates the registration of designs for objects that are intended to be duplicated through industrial processes. Unlike patent rights, which seek to protect an innovation (the idea underlying a method or product), registered design rights seek to simply protect the physical form of a manufactured item.

Registerable Designs:

- The Designs Act No 195 of 1993 makes provision for the registration of both aesthetic designs (Part A registration) and functional designs (Part F registration).
- An aesthetic design is defined as "any design applied to any article, whether for the pattern or the shape or the configuration or the ornamentation thereof, or for any two or more of these purposes, and by whatever means is applied, having features which appeal to and are judged solely by the eye, irrespective of the aesthetic quality thereof." Design features which are necessitated by the function of the article in question, i.e., purely functional features, cannot validly be registered as aesthetic designs.
- A functional design is defined as "any design applied to any article, either for the pattern or the shape or the configuration thereof, or for any two or more of these purposes, and by whatever means it is applied, having features which

are necessitated by the function which the article to which the design is applied, is to perform, and includes an integrated circuit topography, a mask work and a series of mask works."

- Both functional and aesthetic design applications may be lodged in respect of the same article. It is important to note, however, that an aesthetic design registration affords the proprietor of the registration no rights in respect of the purely functional features of the article which is the subject of the registration, or its method of construction. Thus, if it is important that a functional feature of an article also be protected, then it may be necessary to file applications for design protection in both Parts A and F of the designs register.
- "Article" includes any article of manufacture, as well as any part of an article if manufactured separately.
- A design may also be registered in respect of a set of articles of the same general character (which are ordinarily on sale or intended to be used together.)

When the Act was in a process of being established, it was aimed at doing the following:

- to provide for the recognition and registration of indigenous designs;
- to create for this purpose a further part of the designs register; and
- to introduce statutory provisions to provide for the establishment of a National Council in respect of indigenous knowledge, a National Database for the recording of indigenous knowledge and a National Trust and Trust Fund for purposes of indigenous knowledge;
- and to provide for matters incidental thereto.

7.8.5 The importance of intellectual property rights and entrepreneurship in South Africa

In its Congressional Presentation Report for fiscal year 2000, the Government of the Republic of South Africa (RSA) indicated that it is committed to liberal economics, but mounting pressure to produce jobs could derail these changes and undermine the government's legitimacy. Intellectual property laws that support the entrepreneurial spirit, people who start and run businesses, and the creative endeavors of authors, artists, and others by protecting their intellectual property rights can help the South African government achieve its economic reform goals.

The subject of intellectual property rights and its relevance to AmaNdebele entrepreneurial artists has become more crucial than ever before in an ever-expanding global market. The proper functioning of intellectual property can contribute significantly to long-term development. After all, one of the primary functions of intellectual property laws is to boost the economy. A suitable setting is required for the enterprising craft artist to thrive.

Because the entrepreneur exhibits a propensity for invention, risk-taking, and the ability to seek capital, new markets, products, and technology, entrepreneurship is a vital aspect of economic progress. One measure for facilitating economic relations between corporate entities on a national and worldwide level is the protection and enforcement of intellectual property rights laws. Artefact production, for both economic and cultural reasons, requires legal protection from exploitation. Maintaining adequate intellectual property protection serves as a signal to the worldwide business community that a country wants to do business there. To this purpose, AmaNdebele crafts would be conserved, and a viable commerce economy would be established.

7.8.6 The establishment of the Indigenous Knowledge Systems (IKS) policy of 2004

The Indigenous Knowledge Systems (IKS) Policy, which was adopted in November 2004, was the outcome of a multi-departmental effort to develop a framework for the acknowledgement, understanding, integration, and promotion of South Africa's vast indigenous knowledge resources. The involvement of practitioners and holders of Indigenous Knowledge (IK) has been crucial. The Indigenous Knowledge Systems (IKS) Policy is a framework for stimulating and strengthening indigenous knowledge's contribution to South Africa's social and economic development.

The strategy identifies several areas of action, including the protection of indigenous knowledge (such as artefacts) and the people who retain it from exploitation. This would also entail ensuring that communities receive a fair and consistent acknowledgement, as well as, where appropriate, financial compensation, for their knowledge. IKS Policy (2004) was authorized by the Cabinet, with the overarching goal of enabling the recognition, affirmation, promotion, protection, and growth of IK in South Africa. The following are some of the most important policy drivers:

- Affirmation of African cultural values in the face of globalization
- Development of the services provided by traditional healers
- Contribution of indigenous knowledge to the economy
- Interfacing with other knowledge systems.
- NIKSO established by DST in 2006:
- The Department of Science and Technology to implement the Policy.
- Policy implementation in DST focuses on 4th driver: Interfacing IK with other knowledge systems

Following that, the South African Department of Science and Technology (DST) established the National Indigenous Knowledge Systems Office (NIKSO), which oversees bridging the gap between IKS and other recognized knowledge holders in order to provide critical opportunities for the development of new products and services.

7.8.7 Promoting living heritage which was side-lined due to historical imbalances

According to the 2009 draft of the National Policy on Living Heritage in South Africa, "the need for a national policy promoting living heritage is created in South Africa by historical imbalances in the way different communities' living heritage has been regarded, as well as the need for coordination of living heritage, which is managed by various agencies, including communities. Apartheid's history assured that the practice and development of diverse social groups' languages, performing arts, rituals, social practices, and indigenous knowledge were not balanced, and in some cases, intentionally discouraged. South Africa develops from centuries of the political climate in which social groupings were hierarchically graded and some had a legacy that was not openly valued and developed. For example, a false perception was generated that some social groups' traditional dress code and traditional dances were archaic and incompatible with colonially accepted religions like Christianity. Indigenous foods, which were processed using specific ways, are becoming extinct as a result of industrialisation and neglect.

One of South Africa's biggest difficulties is a lack of social cohesion as a result of its history. Racism, xenophobia, criminality, corruption, and, in some circumstances, a lack of ethics and care in institutional and public service are all manifestations of a lack of social cohesion problem. Furthermore, a lack of social cohesion is manifested in a lack of appreciation for cultural diversity. It is also reflected in the widening

socioeconomic divide. This is due to apartheid's ability to incorporate factors of culture and economic position into the classification of social groups. While government programs are addressing the historical legacy of socio-economic inequities, there is a need to release the capacity for South Africans to celebrate their shared social existence by protecting their history and celebrating their equal entitlement to it.

Living heritage is defined as "manifested inter alia in the following sectors," according to the 2003 UNESCO Convention for the Safeguarding of Intangible Cultural Heritage, which South Africa has ratified.

a) Oral traditions and expressions, including language as a vehicle of the intangible cultural heritage b) Performing arts

b) Social practices, rituals, and festive events

c) Knowledge and practices concerning nature and the universe e) Traditional craftsmanship.

Throughout the decades of colonialism in South Africa, certain groups have associated themselves with objectivity while others have associated themselves with superstition. This has resulted in a double marginalization effect: some groups have been estranged from objectivity and scientific heritage, while other components of their past that are not “objective” knowledge (such as the necessity for, and influence of, rituals) have been undervalued. As a result, restitution is required in terms of recognizing objective and subjective elements in all knowledge systems and restoring integrity to their cultural logic, as well as fostering alignment with national and international human rights policy instruments. The problem is to avoid associating entire cultures with superstition or subjective knowledge, as well as associating scientific history with exclusively specific social groupings.

Local communities have managed their changing, living heritage effectively for generations, despite the colonial onslaught on living heritage – the grandmother telling stories to young people around the fire, the potter making pots according to ancient patterns, old ceremonies and new ceremonies and honours are performed. This priceless asset must be actively protected and promoted. People must continue to enjoy and practice their living heritage in order to preserve it. Safeguarding, according to the 2003 Convention, refers to "actions aimed at ensuring the viability of the

intangible cultural heritage, including the identification, documentation, research, preservation, protection, promotion, enhancement, transmission, particularly through formal and non-informal education, as well as the revitalization of the various aspects of such heritage" (The draft of the National Policy on Living Heritage in South Africa ,2009:14).

In South African history, the state's responsibility is to assist in the recognition and celebration of the importance of living legacy traditions by ensuring that:

- processes are created to help people to record their heritage in order to identify and safeguard its value to communities;
- common interests are protected within a democratic state;
- people contribute innovatively to industries (in areas such as medicine) and to tourism, using IKS for innovation;
- people contribute to sustainable economic development and social cohesion and communities continue to celebrate their heritage;
- people are afforded proper coordination of living heritage in South Africa and in relation with other countries; and
- Community participation is integral to the management of living heritage.

The importance of community participation in the preservation of living heritage cannot be overstated. The 2003 Convention recognizes community participation as an essential component of heritage management. This policy framework acknowledges that living heritage is inextricably linked to the communities in which it exists. As a result, and as a policy, it facilitates what is primarily driven by communities. As a result, the policy emphasizes the necessity of community engagement as well as the importance of equity in human and cultural rights, as described previously. Community participation must be obvious in the supported procedures when various governmental and nongovernmental organizations are assisting in the preservation of heritage.

7.8.8 Trademark of Indigenous terms and expressions

By Amendment Act No. 28 of 2013, South Africa revised its Intellectual Property Law to provide for the recognition and protection of some traditional and indigenous phrases or expressions, and their protection has been specifically determined under

the law since then. According to the preamble of the Amendment Act, the designation of Traditional Knowledge (TK) as a cultural resource "would benefit the country and ensure that indigenous communities receive equitable financial advantages."

- to provide for the recognition of indigenous terms and expressions and for the registration of such terms and expressions as trademarks;
- to create for this purpose a further part of the trademarks register;
- to provide for the recording of indigenous terms and expressions; and
- to provide for further protection of geographical indications
- Trademarks may well be used to protect culturally recognised names or symbols, since the lifespan of cultural names or symbols is perpetual in nature and trademark law can accommodate this scenario.

7.8.9 Protecting indigenous cultural expressions through the database

- The Intellectual Property Laws Amendment Act 28. 2013 (the IPLA Act) stated that databases for indigenous knowledge shall be kept in the prescribed manner, at the offices of the registrars of patents, copyright, trademarks, and designs, as part of the existing intellectual property registers where applicable, in the National data base.
- The databases envisioned in subsection (1) will be subsets of existing intellectual property registers, with separate parts for recording information on various manifestations of indigenous cultural expressions or knowledge, as defined in subsection (2). (3).
- All information given to the registrar on manifestations of indigenous cultural expressions or knowledge must be entered into the databases in the prescribed sections.
- The registration of traditional work will be for the objectives of establishing ownership and identifying representation within an indigenous group.
- Unless a benefit-sharing agreement has been reached between the applicant and the relevant authority or indigenous community, no right in a derivative indigenous work allowed for in the Intellectual Property Laws Amendment Act, 2013, will be eligible for registration. If an indigenous community has formed a

community protocol, such protocol must be considered in the contact with the indigenous community envisioned in subsection (4).

7.8.10 Effective protection of Intellectual Property Rights through the South African Intellectual Property Policy Act (IPP) of 2018

The South African Intellectual Property Policy Act of 2018 aims to:

- Provide for the recognition and protection of certain manifestations of indigenous knowledge as a species of intellectual property;
- Amend certain laws so as to provide for the protection of relevant manifestations of indigenous knowledge as a species of intellectual property,
- The promotion of economic empowerment through, among other means, the implementation of the “utility model” to support the registration of patents by resident small, medium and micro-enterprises (SMMEs), historically disadvantaged individuals, and companies who are operating in the informal sector. This entails enacting exclusivity similar to a patent right, granted by a state, to an inventor or the inventor’s assignee, for a fixed period of time. However, the terms and conditions for granting a utility model are slightly different from those for ordinary patent, including a shorter term of protection and less stringent patentability requirements. The term “utility model” is sometimes addressed differently in other countries, with the terms “petty patents”, “short-term patents” or “innovation patents”.
- A coordinated approach to creating awareness about IP among South Africans, so as to protect nationally-owned IP that is related to indigenous resources, traditional innovation and traditional knowledge.
- The creation of a system for protection for traditional knowledge which will guard against misappropriation and exploitation, as well as promote further research and development into products and services based on traditional knowledge.

7.8.11 The protection, promotion and development of the Indigenous Knowledge Systems

The Indigenous Knowledge Systems Act of 2019, according to the Department of Science and Innovation, is primarily about reparations and bringing indigenous

knowledge into the mainstream. It was also a transformative Act since it addressed how indigenous peoples could contribute and integrate into the mainstream economy by utilizing their own indigenous expertise. Governance was one of its goals, as there was the suggestion to form an advisory council that would be diverse in terms of gender and youth. Prior learning was acknowledged, making it easier to transition between formal and prior indigenous knowledge, and an outcomes-based approach was implemented. The Indigenous Knowledge Protection, Promotion, Development, and Management Act 6 of 2019 aims to:

- to provide for the protection, promotion, development and management of indigenous knowledge;
- to provide for the establishment and functions of the National Indigenous Knowledge Systems Office;
- to provide for the management of rights of indigenous knowledge communities;
- to provide for the establishment and functions of the Advisory Panel on indigenous knowledge;
- to provide for access and conditions of access to knowledge of indigenous communities;
- to provide for the recognition of prior learning;
- to provide for the facilitation and coordination of indigenous knowledge-based innovation; and
- to provide for matters incidental thereto.

The IKS Act is a follow-up to South Africa's Intellectual Property Laws Amendment Act, 2013 (the IPLA Act), which was passed into law on December 10, 2013 (after a difficult and protracted journey through the National Assembly). That Act deals with the alteration and "grafting" of IK and ICEs onto four IP Acts (-see below) in order to defend IKS using an IP-based strategy. The IKS Act establishes a National Indigenous Knowledge Systems Office (“NIKSO”) and an Advisory Panel to advise NIKSO, as well as providing sui generis protection for IK. The construction of a National Database is mandated by Section 28C of the Act. Furthermore, Indigenous knowledge databases will be retained as subsections of current intellectual property registers at the offices of the registrars of copyright, trademarks, and designs for this purpose. Separate sections for recording information on various manifestations of indigenous traditional

cultural expressions or knowledge will be included in these databases. Section 28C deals with the "copyright database," but its rules also apply to "trademarks and designs databases" when it comes to applications for registration in order to commercialize them. Currently, there exists a National Indigenous Knowledge Management System (NIKMAS), processes and structures developed through the National Recordal System (NRS) which is responsible for the recording, storing, management and dissemination of Indigenous Knowledge (IK).

7.9 Discussion

7.9.1 Introduction

This section of the study has presented ways AmaNdebele women have established in order to preserve and protect the AmaNdebele mathematical artefacts. Legal documents on the protection, preservation, and management (to count a few) of Indigenous Knowledge were also presented according to the objective of the chapter which was to explore how the AmaNdebele mathematical artefacts have been protected and preserved. The discussion of the chapter's findings is therefore presented below.

7.9.1.1 Knowledge of mathematical artefacts preserved and protected using different methods

AmaNdebele women use different indigenous techniques which they have adopted over the years to preserve the knowledge of mathematical artefacts. They have knowledge transmission techniques which have been handed out from mother to daughter. Indigenous knowledge, according to Szulanski et al. (2016), may be passed down through observation, imitation, and practice because it is tacit knowledge. For tacit knowledge to be conveyed by observation, there must be an interaction between the source and the recipient, personal communication, the recipient's observation of the knowledge in use, and continued practice. Stories, songs, dances, sculptures, paintings, and performances are used to pass on indigenous knowledge from generation to generation. Even though all knowledge transfers need some effort and may be challenging, some transfers are much more difficult than others, and some transfer-related problems will be easily detected and treated on a regular basis (Szulanski et al. 2016).

AmaNdebele women generate income using their mathematical artefacts. They sell artefacts to local and international tourists. This is also a strategy for protecting and preserving culture. Many women become motivated to do AmaNdebele crafts because they know that they will financially benefit from such. Senanayake (2006) expressed that culture has a significant impact on the generation, adaption, and use of indigenous knowledge. Indigenous knowledge is also influenced by economic, social, political, and geographical factors, albeit to a lesser extent (Senanayake, 2006).

Communities employ indigenous knowledge (IK) to make decisions about food security, human and animal health, education, natural resource management, and other critical activities at the local level. IK is a critical component of the poor's social capital, and it is their most valuable asset in their efforts to reclaim control of their lives (Gorjestani, 2004).

Carey (1998: 91) argues in an essay published and edited by Schiama and Eicher that:

> Beadwork enables a woman to become a wage-earner, by making and wearing massive quantities of personal beadwork and posing for photographs (for a fee). Well known are Ndebele of southern Africa or the Maasai of Kenya; ... The above quotation indicates clearly how a natural talent and social habit can be turned around and be used as means to put bread on the table. This could even be better intensified and more reframed. The ladies can organise the photo taking by themselves, frame and sell them to people who love beadwork.

Looking at other sources, Whooper (1988) in her study of Ndebele beads, it was discovered that beads were beneficial to many disadvantaged Ndebele communities, as they helped them economically and provided a steady source of revenue. She writes in her own words:

> In recent years beadwork has also been made for sale in the cities or to visiting dealers, and in this way women in very poor economic circumstances have gained a small independent income. (Whooper, 1988: 3).

Ndebele women in KwaMsiza further stated the tourism sector was their mainstream to generate income and preserve culture. However, since their environment is

neglected by the government, most tourism activities have decreased. Currently, their environment depends solely on them to keep it vibrant for tourism attraction. Along with the positive efforts and policies, there are several areas of concern that could jeopardize Africa's historic treasures' long-term viability. When compared to other endeavours such as defence and health, heritage protection is frequently underfunded. Antiquities departments are understaffed due to a lack of resources, and much of the workforce is inexperienced (Chirikure, 2013).

Chirikure (2013) further elaborated by stating that due to a shortage of resources, delivery is hampered. Furthermore, most countries' legal frameworks were established in the 1970s, before substantial ties between cultural preservation and environmental stewardship were established. Regrettably, such rules make little provision for impact evaluations prior to development. Only Botswana, Namibia, and South Africa have legislation requiring impact studies in the whole Sub-Saharan area. Considering that Africa's economy is based on extractive industries, Arazi (2009) stated that the lack of effective impact assessment frameworks means that most heritage sites, which are a mainstay of palaeosciences, will be destroyed.

In South African amongst others, the White Paper on Arts and Culture, existing Policy on Indigenous Knowledge Systems, the National Heritage Resources Act (NHRA 25 of 1999) and the National Heritage Council Act (NHCA, 11 of 1999) are some of the major policy and legislative frameworks that have set out to define and protect intangible heritage (Chirikure, 2013). Despite the fact that the cultural heritage sector continues to attract visitors and generate economic benefits, the overall contribution of the cultural heritage sector to South African tourism remains unknown due to poor national statistical record keeping, hence making any benchmarking of the current National Culture and Heritage Tourism Strategy difficult. Another source of concern is that South African cultural heritage tourism items have recently been labelled as "substandard" in a number of official visitor reports.

Various research and papers have been published on the issues of managing World Heritage Sites in Africa. Mapesa (2016) revealed that in Uganda, where the Rwenzori Mountains Forest is a World Heritage Site (WHS), the government's act of controlling resources and excluding the Bakonjo communities from becoming part of the site, which they conserved based on their traditional knowledge and laws, has accelerated

a major challenge in the site's management. Mumma (2003) emphasized on the elimination of the community in the management of the WHS, arguing that the adoption of community-based legal systems and community integration will increase the effectiveness of heritage management in Africa.

Sullivan (2004) supports the notion, stating that traditional cultures were more effective in the management of World Heritage Sites than putting regulations on communities. Furthermore, developmental efforts in many African countries have put a lot of pressure on governments to address poverty and heritage resource management and protection. Morgan (2013), for example, expressed concern that the expansion of Lamu's port might jeopardize the integrity and authenticity of Swahili Town, a UNESCO World Heritage Site, both of which are important factors in the World Heritage Site's liquidation.

Political upheaval has been identified (Mbabazi, 2015) and other researchers in several parts of Africa as one of the difficulties facing World Heritage Sites to a greater level. Tassie et al. (2015) documented how the Egyptian revolution of 25 January 2011 posed obstacles in the field of cultural heritage management, including terrorist assaults and sectarian violence that devastated museums, churches, and other historic structures, as well as looting and criminal activities. Moffett (2017) discusses this topic, stating that in Mali, armed battles in Timbuktu resulted in the demolition of 14 mausoleums in 2012. In the Democratic Republic of Congo, political upheaval has had an impact on the management and conservation of World Heritage Sites.

7.9.1.2 Education as a way to preserve culture

AmaNdebele women have remarked that education can help to preserve the knowledge of mathematical artefacts. This entails incorporating Ndebele culture into the classroom's curriculum. Students will be able to connect their home lives to the topic of the class using this type of instruction. This will be a significant step toward the indigenization and decolonization of African education. The devaluation and exclusion of IK from the main stream education process in Africa has been attributed to a number of factors, including modern education systems and related institutionalised knowledge creation processes (Shava, 2016). Shava (2016) stated that curriculum transformation in Africa has been fraught with difficulties, as it has been with other forms of change.

The impact of the colonial legacy and globalisation are two major challenges identified by (Shava & Nkopodi, 2020). Teacher education programs cannot afford to ignore the onslaught of new knowledge management efforts and the need to respond to societal needs, which begins in early teacher education courses (Msila, 2016). In Sub-Saharan Africa, the current paradigm shifts towards supporting education for sustainable development tend towards alternative approaches to school curricula (Owour, 2007). Nkopodi and Mosimege (2009) argued factors for the lack of education in rural areas including the need to address and integrate indigenous knowledge into educational programs, in addition to access to schooling, affordability, and a lack of resources.

However, in order to identify acceptable ways to deal with this information, study into ontological, epistemological, and methodological difficulties must precede the incorporation of IKS in school curriculum (Nhalevilo, 2013). In educational discourse, there is a need for an African Renaissance to show how indigenous African knowledge systems may be used as a fundamental resource for the continent's socio-educational change, as well as how IKS can be politically and economically liberating (Higgs & Van Wyk, 2007). If teacher education incorporates both local and global knowledge assets, it will improve higher education institutions' ability to serve and be relevant to local populations (Msila, 2016).

An increasing number of African intellectuals are now admitting that it is long past time for African traditional knowledge to be recognized in schools (Msila, 2016). By enriching the experiences of learners and teachers, African philosophy of education is supposed to empower communities to engage in their educational growth (Higgs, 2003). In African communities, there are both generalized and specific indigenous knowledge components, according to Shava (2016). Traditional medical practice, creating craft items, hunting, collection, preservation, and food preparation are among the specialized indigenous knowledge components that are allocated asymmetrically based on gender and age, he added.

7.9.1.3 Policy documents in preservation and protection of Indigenous Knowledge

The reviewed policy documents in this chapter provided an in-depth information on the protection and preservation of indigenous knowledge. Some of the documents were also linked to the protection and preservation of AmaNdebele artefacts/crafts. Based on the provided legal documents, it is clear that the South African government over the years has seen the potential of indigenous knowledge and worked on ways to

protect such knowledge. According to the draft National Policy on South African Living Heritage, South Africa's living heritage was neglected for a long period during the apartheid era, and its economic value was overlooked. The National Policy on Living Heritage in South Africa (2009:9) explained in detail that:

> In South Africa, living heritage has significant social and economic value. The importance of living heritage, including popular memory, was identified during the anti-apartheid struggle as an important counterpart to the celebration of colonial buildings and artefacts, which were seen as the main heritage resource. Under apartheid and colonialism, much of the indigenous living heritage was marginalised and even demonised. The living heritage of people indigenous to Africa, and of slaves brought to this country, was affected by dramatic changes in land ownership, livelihoods, language use, and social structure. In democratising the heritage landscape after 1994, it has thus been very important to recognise the significance of living heritage and to safeguard it for future generations.

Therefore, the preservation of cultural heritage is therefore concerned with safeguarding both the tangible representations of culture which includes everyday objects such as clothing and dwellings, as well as art in its many representations, from pottery and beadwork to painting and sculpture and the other, less physical but equally important, aspects of traditional lifeways such as language, oral stories, customs, and beliefs.

Most indigenous peoples' lives, like the AmaNdebele in South Africa, are dominated by artistic endeavors. They act as a common thread that binds the community together. They bring people together via the creation of art as a family or the transmission of a specific art style and skill technique from generation to generation. The Ndebele nation would lose this connection if they were not well protected. The indigenous group's intellectual property includes art, music, and knowledge of medicinal herbs. These cultural aspects contribute to a sense of cultural integrity, identity, and community. Individuals gain a sense of self by passing down traditional skills, traditions, and attitudes. Ndebele wall painting, for example, is a component of their artistic legacy that has been passed down through the years. As a result, intellectual property rights mechanisms should be used to protect all aspects of

Ndebele cultural artefacts. Such will allow the creators to gain both monetary and aesthetic benefits by safeguarding his copyrights. If a creative is given such an incentive to develop and contribute to a nation's cultural activity, the nation, or the public, will invariably profit culturally. The law should benefit the public welfare by supporting the spread of learning and culture by securing liberating, rather than constraining, rights for the creative sector of a society.

Roy (2015) who wrote an article on Indigenous cultural heritage preservation stated that libraries should also be considered as institutions that preserve indigenous knowledge. They contain legal documents that provide people with relevant information. Furthermore, they have written history of African culture and heritage which is need to be passed from one generation to another. Furthermore, libraries have written work on how indigenous research has to be conducted by both indigenous and non-indigenous scholars. It is thus critical to identify libraries as relevant sources of indigenous knowledge history.

Furthermore, Roy acknowledged the critical grown breaking work of Smith (1990) who provided relevant information on indigenous research has stimulated other publications, including Wilson's Research is Ceremony (2008), The Decolonizing Handbook (Denzin et al., 2008), and writings on decolonizing research in other disciplines such as social work (Gray et al., 2013). Martin (2003) calls for an Indigenist approach to conducting research that recognizes Indigenous worldviews, honors their social values, emphasizes the contexts in which they lived, and privileges the Indigenous voice and experience. Both Martin (2003) and Wilson (2008) call on Indigenous scholars to base their research approaches on their Indigenous ontology, or views on reality.

Within the library and archives literature, Lonetree's (2012) Decolonizing Museums specifically examines how the museum setting might be decolonized, and illustrates this concept through detailed case studies of three museums in the United States. Nakata's (2002) concept of the Cultural Interface provides the best model for the interaction between information workers and indigenous peoples and their cultural representations. Indigenous peoples live in this interface, the place where their Indigenous lifeways and western viewpoints, come together, and ‘‘a place of tension that requires constant negotiation’’ (Nakata, 2002: 286). Within this space Indigenous

living may either flourish or be repressed, and it is here that cultural heritage institutions reside. Thus, the role of these institutions, including libraries and archives, within this space cannot be underestimated. Respectful and supportive work within the Cultural Interface can be assisted, however, by a mindful attention to practice—the details of which are introduced in the next section.

Indigenous knowledge, which has traditionally been passed down through the generations by word of mouth, is at risk of extinction unless it is systematically documented and preserved. The future of IK, which reflects many generations of expertise and problem resolution by millions of indigenous people around the world, is questionable, as per (Warren, 1996). IK loss will impoverish society because, just as the earth requires genetic diversity in organisms, knowledge systems require diversity as well (Labelle, 1997). The loss of IK is largely due to the rapid shift in the way of life of local communities.

Because of the effect of modern technology and education, younger generations underestimate the utility of indigenous knowledge systems (IKSs) (Ulluwishewa, 1993). It is clear that unless IK is documented and kept, it will be lost and unavailable to other indigenous systems as well as development workers. Without incorporating local expertise, development programs will not be able to provide long-term answers to local concerns (Warren, 1996). Ignoring people's knowledge nearly guarantees development failure (Brokensha et al., 1980). In reality, IK is essential for local growth (Schoenhoff, 1993).

IK must be gathered, structured, and disseminated in the same systematic manner as Western knowledge since it is critical to growth (Agrawal, 1995; Gonzalez, 1995; Warren & Rajasekaran , 1993). Methodology, access, intellectual property rights, and the media and formats in which to preserve IK are the primary difficulties to its management and preservation. The dilemma of whether or not to employ the Western paradigm for collecting and retaining IK lies at the heart of these difficulties. According to the debate among experts on the approaches for preserving IK, there is no single proper answer to the question.

Ex situ conservation measures, such as isolation, documenting, and storage in worldwide regional and national archives, are recommended by certain researchers (Ulluwishewa, 1993; Warren & Rajasekaran, 1993). Those who advocate for retaining

distinctions between scientific knowledge and IK, on the other hand, have advocated for IK preservation in situ (Agrawal, 1995). The pros and demerits of the dispute over IK preservation approaches, on the other hand, are beyond the purview of this article. In any event, librarians and information specialists have a tendency to organize what has previously been gathered.

Tyler (1978) raises the question of whether we will ever be able to completely articulate knowledge, which is also beyond the scope of this study. According to Tyler (1978), knowledge cannot be isolated, transferred, received, stored, or translated if the said includes of the saying itself, the construction of what was said, and what remains unsaid. Knowledge does not elude or defy cognitive narratives, as collectors of IK and designers of knowledge management systems have proved. For the sake of society, it is critical that IK be preserved and integrated into existing knowledge management systems.

It is not like IK has not been recorded before. Missionaries and colonial district officers, for example, gathered data on traditional land tenure patterns, crop and livestock ownership, and traditional beliefs and ceremonies, to name a few topics. Ex situ preservation, i.e., isolation, documentation, and storage in international, regional, and national data archives, has been the major technique for conserving IK until recently (Brokensha et al., 1980). It is general knowledge that Africa is rich in indigenous knowledge, according to Balogun and Kalusopa (2021). The problem of intellectual property protection is currently a critical topic. However, there is a discussion about how to promote and improve existing knowledge. Which one should be given precedence? Should Africa prioritize the preservation of what it already has or advertise it first in order to raise awareness?

During the African Information Ethics Conference in Pretoria, South Africa in February 2007, members of the IK Panel debated the subject of IK prevention vs protection. The debate was over which one should take precedence. The conversation was lively, and at the conclusion, it was agreed that Africa should focus on promoting indigenous knowledge, particularly in areas such as medicinal plants, wildlife reserves, and the environment, and adding value to the knowledge as a precondition for its protection (Msuya, 2007). While it was accepted that protection was vital, he argued that it should first be widely understood through promotion, followed by protection. Protection prior

to promotion was thought to be an inward-looking strategy. Others in the argument, on the other hand, thought the two should be taken at the same time (Msuya, 2007).

Tanzania has undertaken various efforts to safeguard and preserve IK in the past. The Tanzania Development Gateway database of the Economic and Social Research Foundation is one such attempt (ESRF). The major goal is to improve the government's, donor community's, and Tanzania's developing non-governmental sector's grasp of policy alternatives by building and strengthening human and institutional capacities in economic and social policy analysis and decision-making. The Tanzania Development Gateway, a project that combines information technology and the internet to promote social and economic development in Tanzania, has created an Indigenous Knowledge database, which is a product of the ESRF. The database was created by the ESRF to improve the sharing and dissemination of IK information, experiences, and practices in Tanzania, with the following goals in mind (Ibid, 2007:350):

- provide a platform where IK is captured, stored and disseminated;
- provide a mechanism of sharing this knowledge and also integrate it with modern science and technology to enhance information dissemination;
- promote sharing and dissemination of IK in-formation, experience and practices in Tanzania; and
- in realisation of IK and its contribution to socio-economic development, the database will promote development of IK systems to improve information provision to the local communities.

Similar studies on the protection and preservation of indigenous knowledge were conducted by (Zimu-Biyela, 2016). In her Doctoral study on the management and preservation of indigenous knowledge in Dlangubo village in KwaZulu-Natal, South Africa, due to the inherent importance of IK and its proclivity for exploitation and marginalization, Zimu-Biyela (2016) argued that its management and preservation cannot be done in a vacuum; it must be anchored on a legislative framework that would serve as the overall foundation for maintaining IK.

The South African IKS Policy, for example, emphasizes the necessity of storing IK in databases and protecting it through the South African Intellectual Property Law Amendment Bill of 2008. (Department of Science and Technology IKS Policy 2008).

Because the South African Intellectual Property Law Amendment Bill (2008) has been criticized, this is a major issue. The Copyright Act, Patents Act, Design Act, and Trade Mark Act are the four acts that govern intellectual property rights in South Africa. For a limited time, the Copyright Act No. 98 of 1978 safeguards the original author's subject matter from exploitation (Masango, 2010).

For a limited time, the Patents Act No. 57 of 1978 protects patented work from infringement. The Designs Act No.195 of 1993 protects the designs of seven different types of items, including antiquities, paintings, and other industrial designs. The Trademark Act of 1993 protects the worth of a successful trademark, service mark, or trade dress from being taken advantage of by third parties (Masango 2010:77; Mukuka 2010b; Saurombe 2009). When a patent, copyright, design, or trademark term expires, the protected work or creation reverts to the public domain, where it can be used more or less freely by others (Varadarajan, 2011:383). Mukuka (2010b:137-207) contends that indigenous peoples require inalienable rights.

While some IK researchers, such as Mosimege (2004) and Saurombe (2009; 2017), argue that South Africa (like Brazil and India) has made significant progress in improving IK management and preservation by establishing an IKS Policy in 2004, the National Indigenous Knowledge Systems Office (NIKSO) in 2006, the Intellectual Property Bill Act as amended in 2010, and the Indigenous Knowledge Systems Bill in 2014 (Green, 2008; Moahi, 2007). According to Raphesu (2010), it faces the same issues as other emerging countries in terms of IK management and preservation. The scarcity of dedicated taxonomists to study biodiversity, as well as the lack of organizational frameworks to encourage good IK management and exploitation, are among the issues mentioned. Raphesu (2010) also emphasizes the need of creating awareness through advocacy campaigns and community-based structures that can be used to inform people about government activities aimed at supporting proper IK management and preservation.

Concluding remarks

The results of the documentation and preservation of Ndebele mathematical objects were detailed documented in this section of the study. Its focus was on how KwaMsiza women protect Indigenous Knowledge of artefacts and how they would like to see it further protected for the next generation. The chapter went on to discuss existing legal

documents aimed at safeguarding and sustaining artistic works, cultural expressions and indigenous knowledge systems as a whole. The next chapter focuses on the study's general discussion, conclusion, and recommendations.

CHAPTER 8: GENERAL DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The aim of this study was to explore the origin of AmaNdebele mathematical artefacts in the KwaMsiza, Mabhoko community, North-West province. The view was to understand the genesis of mathematical artefacts both historically and culturally. Furthemore, to investigate the cultural significance of mathematical artefacts and how the KwaMsiza community has protected their indigenous knolwegde. This intention is aligned with calls for indigenous research and valuing indigenous knolwegde Systems. The primary aim of this study was to answer the main question: where do AmaNdebele mathematical artefacts in KwaMsiza, Mabhoko community originate? This question was addressed in the research, and it has made a significant contribution to the body of knowledge in this field. This chapter covers the study's shortcomings as well as the practical implications of the findings. It also highlights some key takeaways and the study's addition to the body of knowledge, as well as making recommendations for stakeholders and researchers.

The questions that guided this study were as follows:

1. Where do the AmaNdebele mathematical artefacts originate?
2. What is the cosmic genesis of the mathematical artefacts?
3. How do AmaNdebele artefacts serve as culture identity?
4. What are the symbolic meanings of AmaAmaNdebele geometric shapes?
5. How is spirituality connected to AmaNdebele mathematical artefacts?
6. What purpose do AmaNdebele artefacts serve?
7. How has the AmaNdebele mathematical artefacts preserved and protected?

The answers to the above research questions are summarized in the following section.

8.2 The Origin of Southern Ndebele mathematics in KwaMsiza, Mabhoko community

The findings of this study indicate that historically, the AmaNdebele mathematical artefacts existed before the 16th century and are believed to have been practiced when the Ndebele people existed. The participants stated that they were not able to recall exactly when the using of mathematical artefacts began but do however have

knowledge that the artefacts served as cultural expression before their forefathers settled in the transavaal around the 16th century. Because there is a lack of documentation, participants stated that most reserchers have claimed that the Ndebele artefacts are relatively new and started being practiced after the Mabhoko war. However, that is not the case but rather, the expression became more elaborate after the war. Levy (1990) argued that when viewed in the context of Ndebele history, the artefacts might thus be regarded as a symbol of ethnic unity that arose from within the group rather than being imposed from beyond. Because this ethnicity is self-defined, it must be recognized.

Because culture is not static but dynamic and fluid, the findings of this study suggest that AmaNdebele artefacts began to alter over time. Three periods of shifting styles of beading were documented in the study. The research also revealed the evolution of mural art and architecture styles. The findings of this study also indicate that AmaNdebele women who are main custodians of artefacts shifted away from using natural resources as beadwork and paint. They have adopted the new methods and currently use glass beads and modern paint. The AmaNdebele women have been able to maintain the artistic work and protect them from one generation to another.

Many researchers have conjectured about the AmaNdebele's early history. Researchers believe the AmaNdebele first arrived in the Transvaal in the 16th century, but the group's socioeconomic structure and the provenance of their mathematical artefacts during and before that period are difficult to pinpoint. As a result, it is crucial to think of oral history as a source of learning about these early changes. Considering oral history as a reliable source of information, it is critical in indigenous research. This is because, accordinging to the Afrocentricity theory, African worldviews are the center of indigenous research and IK is embedded in a worldview which Cobern (1996, 2000) describes as 'non-rational presuppositions on which conceptions of reality are grounded'.

Ndebele people have used their artistic work to convey their culture and identity, based on knowledge passed down from generation to generation regarding the origins of Ndebele mathematical items. The Ndebele nation's mathematical artefacts define their ways of knowing, being, and living. It's also worth noting that many indigenous societies do not place the same value on 'knowledge' as a noun, an object, or an

abstracted product. Knowledge is defined as a "way of being," "a means of knowing," "a way of living in nature," and "a way of belonging" (Aikenhead, 2002; Khupe, 2014). Knowledge as a commodity, a thing separates from ourselves, each other, and our wisdom of life in the moment, assumes a concept of knowledge that does not exist in indigenous worldviews. The researcher has a place in the research from this standpoint, and hiding or omitting this distorts our understanding. The researcher analyzes occurrences and create texts, imprinting themselves on them intentionally or unconsciously. The researcher is not isolated from the study method, location, or context; she is a member of the research community and can learn from it.

The mathematical artefacts of the Ndebele have both historical and cosmological origins. The Ndebele people also think that the practice creating mathematical items is rooted in their spirituality. Religion and belief systems impact the Ndebele people's ways of doing, being, and living. According to their beliefs, the Supreme Being gave them instructions to practice and develop mathematical artefacts over time. Geometric shapes in artefacts have cultural, spiritual and symbolic significance. In explaining the meaning of shapes, it was taken into account that spirituality of the Ndebele people played a vital role in cultural artefact.

Most of the mathematical shapes are linked to ancestral gods and God. Even though there are Ndebele people who have converted to Christianity, most continue to uphold the cultural beliefs and religion. It is worth noting that all of the ethnic groups have some surviving stories about the Supreme Beings, the universe' origins, and indigenous and human life. It is vital to remember that all African ethnic groups believed in supernatural beings long before some of them became Christians. As per Aikenhead (2002), this belief is fundamental to their worldview. The Indigenous theory of this study, which is rooted in indigenous people’s beliefs, worldviews, knowledge, and culture (Kim & Berry, 1993) concurs with the fact that religion is the foundation of how Africans view the world and express their culture.

The knowledge of mathematical shapes has been passed down from one generation to another, specifically from mother to daughter, using indigenous methods developed by AmaNdebele. For centuries, AmaNdebele have used mathematical artefacts knowledge to express their culture and ethnic identity. This is another method developed to preserve knowledge and maintain ethnic identity. Maintaining ethnic

identities, cultural experiences, ethnic values and indigenous worldviews has been advocated by eZiko Sisophula theory (Goduka, 2005) of this study. AmaNdebele proud themselves about who they are and use the artefacts as cultural symbolism. As the world continues to evolve, AmaNdebele women continually work tirelessly to maintain and preserve the AmaNdebele artefacts. Each year, celebrations and ritual ceremonies are held to express the identity of the AmaNdebele. Commemorations and ceremonies are also a reminder of hardships injured by the AmaNdebele and encouragement to continue expressing ethnic identity by practicing mathematical artefacts. Annual ceremonies further motivate AmaNdebele to work together and continue to participate in preserving culture. This is in line with the eZiko Sipheka Sisophula theory, which promotes participatory, collective, and communal methods of preserving and defending indigenous knowledge.

AmaNdebele women have been inspired to preserve their cultural identity because of such annual commemorations and ceremonial activities. They have resolved to finding further methods of conserving mathematical knowledge by selling artefacts and converting their homesteads into tourist attractions, which is something that is not new but started in the 1950s according to (Nettleton, 2014). Furthermore, because the KwaMsiza community continues to practice Ndebele traditions, their homes have been designated as cultural heritage sites. However, it has been highlighted that the government has neglected in maintaining their houses over time, forcing them to shoulder the obligation themselves, in order to continue their businesses. Because of bad management, the business has become slow and unpopular over time. AmaNdebele women, on the other hand, continue to create artefacts and follow popular fashion trends in order to attract even local buyers (Levy, 1990).

Developing measures to protect indigenous knowledge is critical and urgent for the AmaNdebele women in the KwaMsiza Mabhoko community. As a result, they have stated that this knowledge should be taught in schools so that children may comprehend their own culture. The participants believe that it is past time for cultural history and experiences to be taught and learned in schools. Many indigenous scholars have argued for the incorporation of indigenous knowledge systems in the school curriculum at all levels (Nhalevilo, 2013; Msila, 2016; Shizha, 2014). Integrating indigenous knowledge into the curriculum helps to decolonize and indigenize education, which is a goal pursued by many indigenous scholars.

The legal documents examined in this study from South Africa detailed how artistic creations have been safeguarded and administered. To analyze how South Africa has secured people's intellectual property, a review of such legal documents is required. Many people are unaware of the legal laws in place to preserve their intellectual property rights. They are used by cultural brokers who deprive them of certain benefits. Entrepreneurs in the AmaNdebele community are no strangers to extortion and being exploited (Mashiyane, 2006). They have been exhibiting their artistic work outside of South Africa since the 1980s, if not earlier. Some of their work was taken for free, while others were taken for extremely low sums. Many works of AmaNdebele art are on display in Western libraries and are available for sale at great rates. Some artistic work has also been sold to visitors in South Africa, who then resell it at a greater price.

There have been no advocates for the AmaNdebele's intellectual property for a long time. Individuals have approached AmaNdebele women, promising them good fortunes, pressuring them to sign contracts they did not comprehend, and robbing them of their property. AmaNdebele women, who were largely elderly and illiterate, were unaware of any legislation that would protect their expertise, which is why they were exploited (Mashiyane, 2006). In the past, the South African government made little effort to educate individuals about their intellectual property rights, resulting in a mushroom of exploitation and intellectual property theft.

The rights of knowledge holders have only lately been extensively articulated in policy papers such as the IKS policy of 2004 and the IKS Act of 2019. Different government agencies have backed such measures, and platforms like NIKSO which have been designed to help individuals better understand their intellectual property rights. Departments have also employed individuals to hold community meetings and distribute detailed intellectual property information. Such measures are important because they protect indigenous people from further exploitation. Indigenous communities like KwaMsiza may comfortably perform their crafts while expressing their culture, knowing that there are policy documents and government departments in place to safeguard their indigenous knowledge while also allowing them to gain from it if others choose to associate with them.

8.3 Limitations of the study and reflections

When conducting the study, the researcher encountered several challenges which were identified as follows:

8.3.1 Member checking

During the data collection process, the researcher discovered that key information for the study was lacking. The researcher continued to examine the data and determined that it was necessary to return to the community for member checking with more probing questions. On Chapters 4 and 5, gaps in the study were detected, necessitating the probing of questions and member checking process. This impacted the time frame available to the researcher for data collection and analysis. Member checking was necessary since crucial research data had not been collected, which had a negative impact on the entire study. As a result, the researcher was able to obtain important data from participants, analyze it, and report the findings shortly after returning to the community for probing questions. The study promoter, who even submitted a recommendation letter to the researcher on the importance of returning back to the study participants after detecting comparable gaps as the researcher, supported and saw member checking as a necessity for this study (see Figure 8.1)

FACULTY OF
NATURAL AND AGRICULTURE
SCIENCES

INDIGENOUS KNOWLEDGE
SYSTEMS (IKS) CENTRE

Tel: 018 389 2453 . Website: www.nwu.ac.za

Ms Monicca Bhuda
P.O BOX 925
Kwaggafontein
Empumalanga
0458
14/12/2021

SUBJECT: REVISIT TO THE PARTICIPANTS FOR THE IKS PhD STUDY

Dear Ms Bhuda

After reading your PhD study, I have noticed certain gaps in other chapters that do not do honor to the research project's goal. Some details are missing, while others require further investigation. As a result, I urge that you review my suggestions and revisit your participants to close any gaps. As a response, you will have the opportunity to submit additional information or to report the study's shortcomings as part of the limitations section. The gaps discovered in this study must be filled, and you will need to recollect and add specific data in order for it to achieve its goals and overcome its challenges. It is worth noting that you will not be gathering data from scratch; rather, you will be filling in gaps that would weaken the study.

As your promoter, I would appreciate it if you could complete this by the end of January so that you may quickly arrange your PhD's plan for 2022. We might hold weekly meetings soon after your revisit the participants, just to make sure you are on track and avoid any future study delays. I am looking forward to hearing from you soon so that I can be completely prepared for your response and the progress of your PhD studies in 2022.
Regards,

Kind regards

Dr Motheo Koitsiwe
Promoter
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Figure 8. 1 Member checking recommendation letter by PhD promoter

8.3.2 Monetary compensations

When the researcher approached the community leaders and explained the study, it was made very clear that the community will want money vefore partaking in the study. The community leaders identified potential participants and the amount that will be needed for each participant. The letter from the Indigenous Knolwedge Systems centre and traditional authority did not have much impact of participants because they insisted that they woild share their knowledge in exchange for money. As per the requests, the researcher had to compensate the participants and buy them refreshments (see figure 8.1) time and again. This was done and maintained until the end of data collection.

Figure 8. 2: Participants indulging in refreshments

8.3.3 Covid-19 and fear to participate

This research was conducted during the Covid-19 outbreak, which presented numerous problems. Participants initially consented to participate in the study but later expressed reservations about doing so. Their greatest worry was becoming infected with Covid-19 and putting their lives in danger because they did not trust the researcher and her assistants, who were not from the same community. Participants felt comfortable participating in the study once they had appropriate information on the virus. Some of the participants wore facial masks at one point, which the researcher approved. During the data gathering stage, anyone who felt poorly was free to leave and relax. The presence of the Covid-19 in South Africa deterred the researcher from continuing the study at one point. She experienced setbacks and had to adjust to her new normal before returning to her studies.

8.3.4 Suspension of Initiation Schools due to Covid-19

The male initiation procedures were also included in the research. The study's sixth chapter examined how cultural identity is communicated using mathematical artefacts. The researcher was expected to observe how mathematical artefacts are embarrassed during various ceremonies that take place at initiates' homes as well as on the day of the newly initiated men's return. Winter initiation for males was, however, banned by the government due to Covid-19, after many Ndebele organizations and chiefdoms raised grave concerns about the male initiation institutions. They had submitted letters of concern (see Figures 8.3, 8.4, and 8.5) requesting that the initiation procedure be suspended. They are optimistic that the process will resume in 2022 once it is safe to do so. The Department of co-operative governance and traditional affairs in Mpumalanga province also issued a formal statement that assured the public of 2021 male winter suspension (see figure 8.6). Such statement was very crucial in the Mpumalanga province because it is the main hub of Ndzundza Ndebele male initiation, and the public required a formal statement for clarification.

As a result, such outcomes had a minor impact on the study, and the researcher needed to use a different method to gain access to data and existing photographs from some participants that they had decided to utilize in the study. The researcher accepted the suspension of male initiation schools and used the data and photographs available to present the findings and continue the investigation. Fortunately, female initiation, which took place from late spring 2020 to late summer 2021, was allowed, and the researcher was able to collect data without difficulty.

After extensive consultation with the government and the community, the Ndzundza traditional authority published a formal statement of male initiations (ingoma) in February 2022. The traditional authority of the Ndzundza Mabhoko chose to proceed with the initiation process under stringent Covid-19 guidelines (see figure 8.7). The study will be submitted for examination before the 25th of April and the 1st of July, and the researcher will not be able to see the procedure for the purposes of this thesis. The researcher will, however, perform a study that relates to home coming ritual ceremonies undertaken during male initiation and cultural expressions for publication purposes and her academic career advancement.

NDZUNDZA AZIBUYE EMASISWENI

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Registration Address:
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Mpumalanga
2233

Date: 11 March 2021

To:
The Presidency (malebo@presidency.gov.za)
The National House of Traditional Leaders (FaithR@cogta.gov.za)
National Department of Health (minister@health.gov.za)
COGTA (MandisaMB@cogta.gov.za)

Subject: Winter Initiation Season during the Covid-19 Pandemic

Good Afternoon

We as Ndzundza Azibuye Emasisweni are a Non-Profit Company that seeks to develop, preserve, protect and promote culture & heritage of the Ndebele-Ndzundza Nation. We would like to ask for direction about the winter initiation season while the country is still within the Covid-19 pandemic.

The traditional practice of the Ndzundza nation is to hold Ingoma (Winter Initiation), once every four years after the leap year. Currently this year 2021, is the time to hold ingoma in different provinces (i.e. Mpumalanga, Gauteng, Limpopo and North West). We understand that this year we are faced with the deadly diseases called Covid-19 and must take into consideration the consequences that comes with Covid-19.

We write this letter to ask for advise from the government about the forecast of the disease within the months of May, June and July 2021. We do not want to make a decision that is a gamble to the forthcoming initiates who are the future of the Ndzundza Nation.

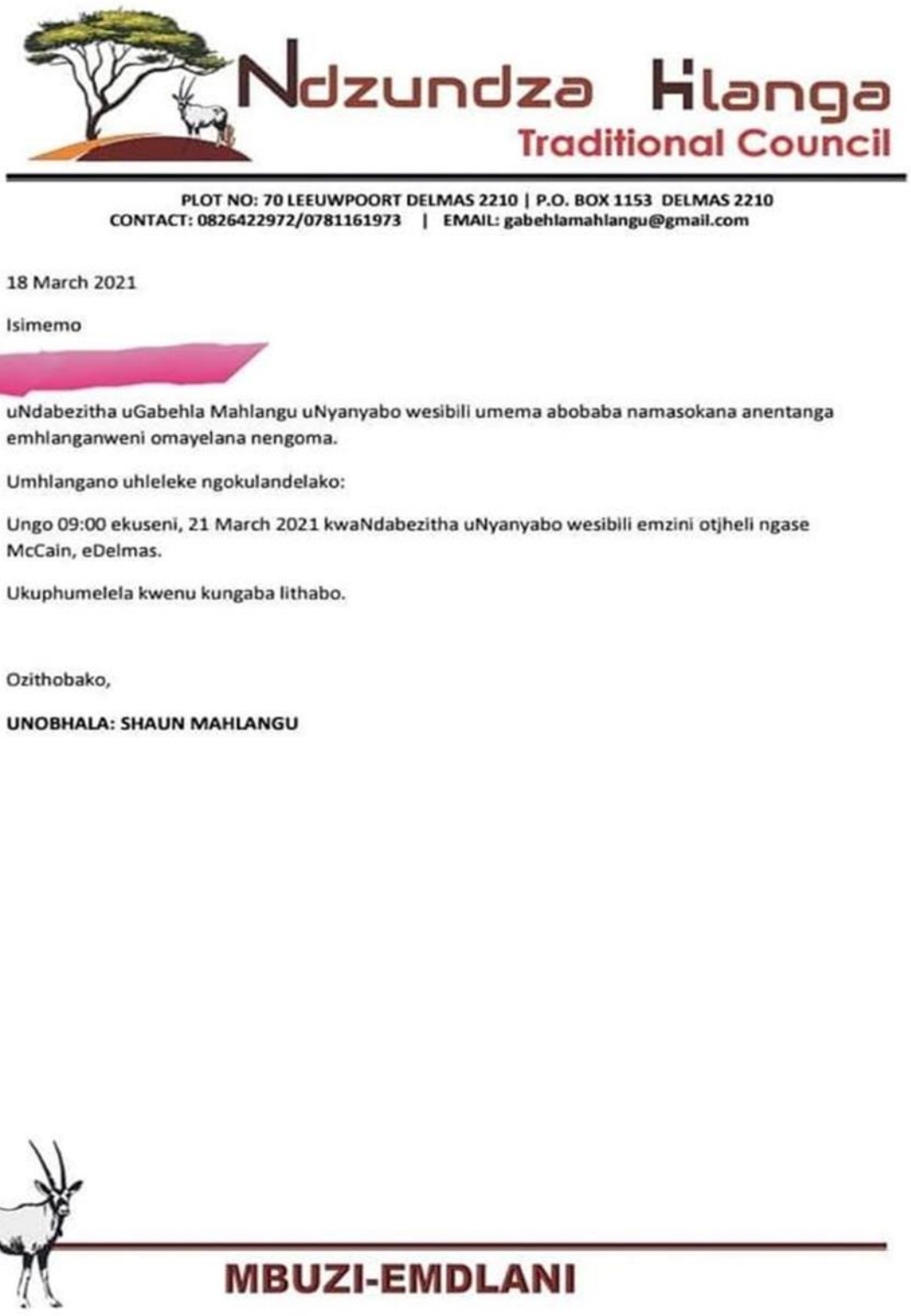
May the responsible departments in government give us direction of whether to halt the initiation season until all South Africans are vaccinated and the spread of this deadly diseases is reduced. We write in good faith and pleading to the National leaders to lead us, so that we do not see mushrooming illegal initiation schools that may cause loss of life to the youth of this country.

May the President, Minister of Health, Chairperson of NHTL and the Minister of Cooperative Governance and Traditional Affairs gazette what should happen this winter with regards to initiation schools in all the provinces of the Republic of South Africa.

Siyathokoza,

Makhosini SoMbusi Mahlangu
Ndzundza Azibuye Emasisweni
Acting National Coordinator
Cell: 081 479 4371
e-mail: sombusi@kwaNdzundza.org.za

Figure 8. 3: Letter for the call of winter initiation suspension



Ndzundza Hlanga
Traditional Council

PLOT NO: 70 LEEUWPOORT DELMAS 2210 | P.O. BOX 1153 DELMAS 2210
CONTACT: 0826422972/0781161973 | EMAIL: gabehlamahlangu@gmail.com

18 March 2021

Isimemo

[redacted]

uNdabezitha uGabehla Mahlangu uNyanyabo wesibili umema abobaba namasokana anentanga emhlanganweni omayelana nengoma.

Umhlangano uhleleke ngokulandelako:

Ungo 09:00 ekuseni, 21 March 2021 kwaNdabezitha uNyanyabo wesibili emzini otjheli ngase McCain, eDelmas.

Ukuphumelela kwenu kungaba lithabo.

Ozithobako,

UNOBHALA: SHAUN MAHLANGU

MBUZI-EMDLANI

Figure 8. 4: Letter requesting a local meeting regarding the suspension of winter male initiation.

To: All Media

Attention: News Editors

Date: 23 April 2021

For Immediate Release

SUSPENSION OF GAUTENG 2021 WINTER INITIATION SEASON

The Gauteng Initiation Task Team which is comprised of Traditional Leaders, COGTA,
Municipalities, Sector Departments, SAPS and CRL Rights Commission, held consultative workshops across the five Regions in Gauteng. The workshops took place in the following Regions:
- Sedibeng
- West Rand
- City of Joburg
- City of Ekurhuleni
- City of Tshwane

The Purpose of the workshops was to engage the Primary stakeholders, which are the Initiation School Principals within each of the Regions/Municipalities on whether to hold initiation or to suspend the 2021 winter season.

Detailed presentations were made from the Gauteng department of Health, with specific focus on the continued impact of Covid 19 in Gauteng.

We also had detailed presentations from the National House of Traditional Leaders with specific focus on the process to be followed during Lockdown Level 1 should anyone wish to hold initiation.

The two Traditional Authorities namely Amandebele Ba Lebelo and Amandebele Ndzundza Sokhulumi, decided to suspend initiation for the 2021 season.

All the stakeholders in each Region, having considered all inputs, unanimously decided to suspend the 2021 winter initiation season. The Primary reason for the decision by all stakeholders was:

- The devastating impact of the Covid 19 second wave in our communities.

- Many stakeholders felt that we should wait for the vaccination rollout to take effect before commencing with initiation.

- The safety of initiates

Following the above mentioned consultative workshops, the Gauteng Initiation Task Team resolved as follows with respect to the winter season initiation:

- **THE 2021 WINTER INITIATION SEASON IS SUSPENDED**

- **ANYONE ATTEMPTING OR CONDUCTING INITIATION MUST BE DEALT WITH BY THE LAW ENFORCEMENT AGENCIES AS THEY WILL BE IN CONTRAVENTION OF THE LAW**
- **OUR MONITORING TEAMS MUST REMAIN ON THE ALERT FOR ANY INCIDENTS OF ILLEGAL INITIATION TO RESCUE OUR CHILDREN, PARTICULARLY IN THE HOT SPOT AREAS**
- **EMBARK ON AN INTENSIVE AWARENESS AND COMMUNICATION OF THE SUSPENSION DECISION TO ALL COMMUNITIES.**

We plead with all our Communities to abide by this decision.

END
For Media Enquiries
Prince George Mahlangu
Chairperson: Gauteng Initiation Task Team
Contact: 083 485 6816 email: mahlangug@gmail.com

Figure 8. 5: Letter confirming the suspension of winter male initiation in Guteng Province.

co-operative governance
& traditional affairs
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

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Litiko
Lekubusa
ngekubambisana
netebuholi bendzabuko

Departement van
Kooperatiewe Regering
en Tradisionele Sake

umNyango
wezekuBusa
ngokuHlanganyela
neeNdaba zamaKhosi

Ref: 9/4/1

MEDIA ADVISORY

All Editors
All Media Houses

MPUMALANGA SUSPENDS INGOMA SEASON TO MITIGATE COVID19 INFECTIONS.

The Department of Co-operative Governance and Traditional Affairs (COGTA) in Mpumalanga has suspended the initiation school season (ingoma) until further notice. This is in line with the Disaster Management regulations outlined by the National Department of Cooperative Governance, as one of the preventative measures against the spread of the corona virus.

MEC for COGTA in Mpumalanga, Mr Mandla Msibi urged the institution of traditional leadership to adhere to the regulation as the country implementing extraordinary measures to curb more infections. "Regulation.....directs the institution of traditional leadership to suspend all cultural activities to curb human contact. Ingoma is in this category and any deviation may further exercebate the infections. Therefore we urge traditional leaders and parents to adhere to these preventative measures. We urge Amakhosi/Makgoshi to further advocate for adherence by all people within their jurisdiction. This will curb further infections and any any violation will be liable for penalties," Mr Msibi said.

Mr Msibi expressed satisfaction about the decision to suspend all cultural ceremonies, as announced by the Provincial House of Traditional Leaders. "Cultural functions are a fertile ground for the spread of the virus through social contact. They are attended by communities in their hundreds. We commend the Provincial House of Traditional Leaders, under the leadership of the Chairperson, Inkhosi Sandile Ngomane for the decision to suspend the ceremonies. It is a major step towards the mitigation of potential infections", he said.

End.

Issued by the Department of Co-operative Governance and Traditional Affairs,
Contact Person: Mr George Mthethwa
Contact Numbers: 013 766 6572/ 083 302 2774
E-mail: gpmthethwa@mpg.gov.za
Facebook: @mpucogta
Twitter: @cogtamp
Date: 28 March 2020

MPUMALANGA
THE PLACE OF THE RISING SUN

Figure 8. 6: Mpumalanga letter of ingoma season suspension.

NDZUNDZA MABHOKO ROYAL COUNCIL

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Media Release
Subject: Ndzundza Kingdom – iNgoma 2022

The Department of Co-operative Governance and Traditional Affairs (COGTA) in Mpumalanga suspended the initiation school season (iNgoma) in the year 2021 until further notice. This was in line with the Disaster Management regulations outlined by the National Department of Cooperative Governance, as one of the preventative measures against the spread of the corona virus.

We the Ndzundza Mabhoko Royal Kraal would like to confirm that the initiation season (iNgoma) will commence for the year 2022 from the 25th of April 2022 at the eMthambothini Royal Palace (Esgodlweni) until the 1st of July 2022. These dates exclude the traditional ceremonies which will be held after initiation school, the traditional home coming ceremonies will take at-least two weeks.

The Municipalities which will be affected by iNgoma under the Ndzundza Kingdom, are the following:

Mpumalanga Province

a. Dr JS Moroka Local Municipality
b. Thembisile Hani Local Municipality
c. Victor Khanye Municipality
d. Emalahleni Local Municipality
e. Steve Tshwete Local Municipality
f. Albert Luthuli Municipality
g. Govern Mbeki Local Municipality
h. Lekwa Local Municipality
i. Msukaligwa Local Municipality
j. Emakhazeni Local Municipality
k. Thaba Chweu Local Municipality
l. Pixley ka Seme Local Municipality

Gauteng Province

a. City of Ekurhuleni Metropolitan Municipality
b. Tshwane Metropolitan Municipality
c. City of Johannesburg Metropolitan Municipality (Region A and C)
d. Lesedi Local Municipality

Limpopo Province

a. Elias Motsoaledi Local Municipality
b. Ephraim Mogale Local Municipality
c. Fetakgomo Tubatse Local Municipality

North West Province

a. Madibeng Local Municipality
b. JB Marks Local Municipality

We believe that through cooperation with relevant stakeholders, the iNgoma 2022 will be a success.

Regards,

Mntwakosi Zilani Mahlangu

Figure 8. 7: Letter from Ndzundza Mabhoko royal council about 2022 male initiation season

8.3.5 Prohibitation of social gatherings due to Covid-19

Apart from suspending the male initiation procedure, the government also restricted social gatherings in 2020 and early 2021 when the researcher was collecting data and lifted the prohibition in accordance with the level of lockdown and the relaxing of restrictions. However, based on what they have seen throughout the country, the Ndzundza Ndebele traditional authority, which holds annual commemorations in several locations, has decided to suspend such gatherings as well. Their biggest concern was that Covid-19 would spread among the AmaNdebele, resulting in many deaths. When the researcher began the research process in 2019, she did have the opportunity to attend a few commemorations (see Figure 8.8, 8.9) where she observed the environment, activities taking place and main theme of traditional leaders. In most of the ceremonies attended, the researcher has learned that most leaders encourage people to preserve their culture, tradition, and languages. They also urged artists to commercialize AmaNdebele artefacts to support their livelihoods while simultaneously promoting and preserving cultural knowledge.

Figure 8. 8: The researcher at an annual Ndzundza Ndebele commemoration in eMthambothini village

Figure 8. 9: Researcher participating in an annual Ndebele commemoration held in Pretoria where a late Ndebele King Nyabela was arrested by Boers.

It should be noted that even though social gatherings continued to be prohibited due to Covid-19 and adjusted according to lockdown levels, the Ndzundza traditional leadership consulted about the King Nyabela commemoration that takes place December annually. Based on the easing of lockdown regulations during the end of the year, government allowed the Ndzundza traditional leadership to host the King Nyabela day in December 2021 while adhering to the lockdown regulations. The invitation to attend this commemoration was announced and posted on a social media platform called Facebook (see Figure 8.10). The researcher of the study visited the place called erholweni where the Mabhoko caves are. This is the place where the annual commemoration is held, and she was able to observe activities done and messages shared by the traditional leaders (See Figure 8.11). The King Nyabela commemoration day celebration was important to the researcher because the Mapoch/ Mabhoko war happened under King Nyabela's leadership and mathematical ideas and concepts were greatly expressed after ther war (cf. 4.5).

Figure 8. 10: King Nyabela commemoration day Facebook post

Figure 8. 11: The researcher at the King Nyabela commemoration day

8.4 Lessons learned from the study

In order to undertake a study with indigenous communities that takes into account indigenous worldviews, observes customary laws, and is led by Ubuntu, the researcher allowed the philosophical underpinnings of this study to guide her throughout the research process. As a member of the AmaNdebele, the researcher recognized the need of conducting a study using an indigenous lens (cf. 1.6). She did not wish to impose her own viewpoint on the participants, preferring instead to allow them to share their own knowledge without feeling inferior or undervalued.

The researcher conducted the research using an AmaNdebele language and asked questions about the meaning of certain terminology she did not understand. Working with the AmaNdebele in their own language gave them trust that the researcher would present findings that reflected and represented their culture. They were confident that the researcher, who is from the same community and speaks the language, would not misinterpret the findings. According to research, communicating in participants' native languages acknowledges local culture and customs, allowing for genuine engagement and the collection of genuine data (Khupe, 2014; Louis, 2007) The use of indigenous people's native languages in research recognises that those languages are valuable and valid, and it shows a commitment to create equity in the research process between researchers and participating communities. The incorporation of the isiNdebele language in the research framework aided meaningful engagement, collaboration, and the generation of authentic data in this study.

This study was crucial for the researcher in correcting misunderstandings and misinterpretations of Ndebele culture and the history of mathematical artefacts. With so many theories from non-Ndebele scholars, it was only natural for this indigenous scholar, who is Ndebele by birth, to undertake a study on her own people and report appropriate results from the knowledge holders. Establishing an ongoing relationship with the traditional authority of Ndzundza Mabusa has enabled the researcher to attend important functions organized by the traditional authority in order to gain insights of the mission to unite AmaNdebele and preserve their indigenous knowledge protected through mathematical artefacts. Because of the researcher's relationship with the King, it was also simple to obtain permission from traditional authorities to conduct a study in the KwaMsiza Mabhoko community. Indigenous researchers such

as Smith (2000), Wilson (2008), Chilisa (2012), Khupe (2014) and Kovach (2015) have advocated for the establishment of continuing partnerships between researchers and indigenous communities.

Instead of being about the KwaMsiza, Mabhoko community, the entire study process was undertaken with them. As a result, they were treated as partners in this research rather than as subjects, as non-indigenous scholars see indigenous communities. Because the researcher was conducting an indigenous study through an indigenous lens, she realized she needed to approach the process as a child rather than a knower. As a result, she needed to learn from the community and build trust. The participants welcomed to the researcher warmly (see Figure 8.12) and were able to share their knowledge with her and treat her as if she were one of them because of her approach. According to Wilson (2008), research with indigenous groups should be undertaken in the manner of a ritual rite, with traditional methodology serving as the foundation. Taking Wilson's (2008) arguments into account, the researcher actively participated in activities and ceremonies led by participants, which served as a learning opportunity.

The researcher was given Jam (Figure 8.13) and a Beret (Figure 8.14) as gestures of appreciation after the data collection process. Participants made such gestures because of the relationship the researcher built with them and the strategy the researcher took throughout the data collection procedure. As a result of the community's warm reception, the researcher decided to give away her children's books, which are written in both IsiNdebele and English (See Figure 8.15). The books will provide young girls with an understanding of mural art and how most Ndebele girls are educated to paint.

Figure 8. 12: Participants welcoming the reseeracher on the first stage of data collection

Figure 8. 13: Researcher receiving Jam from participants as a gift

Figure 8. 14: Researcher receiving a beret from a participant as a gift

Figure 8. 15: The researcher gifting young girls with her Children story book

For the researcher, writing of the children's book during the period of the PhD thesis was not only to explore her other talents but also a strategy to document and disseminate the IsiNdebele mathematics. Just like many other Ndebele people, the researcher hopes that this book can be included in schools, be part of the local gallery archives and part of the libraries. The researcher has taken an initiative to approach the Mpumalanga Department of Sport, Art, and Culture (DSAC) about the inclusion of

the children's books and the Ikghodwana cultural village management to include the book in their small collection (see Figure 8.16). She believes that this would be her contribution to her people for passing this knowledge to her wit hopes that she will preserve it.

Figure 8. 16: The researcher at e*Kghodwana* cultural village

The researcher highlighted that the KwaMsiza Mabhoko community lacks effective representation, which explains why they are unable to overcome so many obstacles, among the other concerns identified by the interviewees. In comparison to when the government was completely involved, their infrastructure has been abandoned, and settlements have become less appealing. This is due to a lack of representation on the ground and a reliance on traditional leadership.

The researcher has considered their worries and hopes that, as an academic, she will be able to bring them to the attention of the relevant people. Furthermore, as a newly appointed member of the Department of Sport, Arts and Culture's Indigenous Knowledge/Intangible Heritage national authentication Panel (see Figure 8.17), she will have influence in government and get advice from relevant people of how to help sustain the KwaMsiza community heritage site. The researcher will further be working

with different indigenous communities and develop ways to promote, protect their cultural heritage. Her appointment will help her learn and comprehend the government procedures that must be followed in order to reach her ultimate goal, which is the preservation, distribution, and protection of indigenous knowledge systems.

This appointment occurred at a critical time for indigenous peoples, as they face numerous issues such as intellectual theft and traditional knowledge not being included in the curriculum. The researcher hopes that once there is proper representation, which she wants to be, some issues will be able to be solved, using proper government channels.

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Ms Monicca Thulisile Bhuda
P O Box 11316
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Dear Ms Bhuda

APPOINTMENT TO THE INDIGENOUS KNOWLEDGE / INTANGIBLE CULTURAL HERITAGE NATIONAL AUTHENTICATION PANEL

It gives me great pleasure to inform you that you have been appointed to serve as a member of the Indigenous Knowledge / Intangible Cultural Heritage National Authentication Panel on a three-year term starting from **01 August 2021** to **31 July 2024**.

The Department of Sport, Arts and Culture will cover travelling, accommodation and honoraria to members who are not in the employ of the state as determined by the National Treasury and will be in accordance with the relevant category of the National Treasury Guidelines.

Kindly confirm acceptance of your appointment in writing by 31 July 2021 to Ms B Makhuba email: Bessiem@dsac.gov.za.

Should you require more information on your appointment, you may contact Ms B Makhuba on 063 641 7839.

I wish you all the best for your term of office.

Yours sincerely

MR E.N. MTHETHWA, MP
MINISTER OF SPORT, ARTS AND CULTURE
DATE: 20-1 07 22

Figure 8. 17: Letter of appointment from the department of Sport, Arts and culture.

8.5 Contributions of the study to the bodies of knowledge

This study has contributed to discipline of indigenous knowledge in different ways which are as follows:

8.5.1 Indigenous research

Because of the need to link research objectives and methodologies to community needs and context; the meaningful integration of knowledge gained through research into Indigenous ways of knowing and being; interview methods; and the role of trust and accountability in researcher-interviewee relationships, indigenous research must be conducted through an indigenous lens. It is vital to remember that indigenous research is done by and with indigenous peoples. The researcher need to keep in mind that there are many ways to work with indigenous communities which is something that was identified by the study research when working with the KwaMsiza community.

Respecting Indigenous Knowledge, decolonizing methodologies, and what community-based and community-led research looks like are all topics that have been extensively researched and needs to be applied in research by both indigenous and nonindigenous communities. The researcher has made fair attempts in conducting a research study that represents the values and ethics of the KwaMsiza, Mabhoko community. In the past, just like most communities, the KwaMsiza Mabhoko people historically have been exploited by researchers, necessitating the use of participatory and decolonizing research methods (African philosophical underpinnings) which this study has in detailed discussed. This study has used an indigenous lense to understand the worldviews of the AmaNdebele in terms of the mathematical artefacts' history. By conducting this indigenous research, the researcher has interrogated the powerful social relationships that marginalize Indigenous knowledge hence, a decolonizing perspective was important to this Indigenous research.

Examining the power dynamics that exist within the Indigenous people's dynamic, allowed for a type of praxis that sought for voice and representation in the midst of research that has traditionally marginalized and suppressed Indigenous peoples. Holding Western beliefs and procedures to be "real science" marginalizes Indigenous knowledge and practices by dismissing them as folklore or myth. The researcher has

focused this study on indigenous ways of doing, living, and being in order to contribute to decolonizing research.

8.5.2 Research on the legal protection of indigenous knowledge and benefit sharing

This study argued that there are currently legal documents which protect the indigenous knowledge Systems of AmaNdebele. However, the people for a very long time did not have knolwege of such documents hence the reason why some have been exploited and taken advantage of. This is the reason NIKSO, NIKMAS and NRS exist in order to ensure that people benefit from their Indigenous knowledge. It should be remembered that indigenous knowledge is holistic and community-owned, which contradicts the spirit and provisions of patent legislation; and second, other forms of management, governance, and rights regimes exist for protecting indigenous intellectual property that provide similar and long-term returns to those who own it (Tom et al., 2019).

AmaNdebele mathematical artefacts are considered as a legitimate type of intellectual property that can be more easily understood as a form of capital that legal, economic, and market-based systems can handle. It also places indigenous knowledge in a context that facilitates the creation of market-based values. Such a method may provide the required scope for the development of systems that value indigenous knowledge appropriately and accurately in innovation and development projects, and also provide the equity (defined as fairness, balance, and opportunity) that AmaNdebele communities and individuals require to create wealth. For some indigenous communities and individuals to overcome the cycles of poverty institutionalized by colonialism, economic and legal acknowledgement of the significance of indigenous knowledge in the development of wealth through innovation is required.

8.5.3 Integration and mainstreaming of indigenous knowledge in the curriculum

This study argued that the KwaMsiza Mabhoko community called for the inclusion of their knowledge in schools. They have not suggested any strategies on how that could be done but they hoped that the researcher could assist in developing methods. The elders are willing to share their knowledge so that it could be part of everyday learning in schools. In response to UNESCO's (1999) request, a number of indigenous writers have proposed that classroom teaching should be linked to students' cultural

backgrounds (Cajete, 1995; Kawagley, 1995; McKinley, 2005; Kawagley & Barnhardt, 2008). For the people in KwaMsiza, the integraton of Ndebele indigenous knowledge in the curriculum will allow the students to relate to their home background with the classromm content. However, IK integration in the classroom should not be one-way, as this portrays IK as small, ineffective, and grounded, and is akin to assimilation (Naidoo, 2005).

8.6 Areas for further studies in the future

For future research, the researcher made suggestions in the following areas:

1. Decolonization of research in high institutions of African states
2. The integration of indigenous knowledge systems in the curriculum
3. The role of legal documents in promoting the intellectual rights of indigenous people
4. Indigenous knowledge and economic development in Africa
5. History of mathematics and science in African states before colonization
6. Forms of expressing Culture identity and ethnicity in Africa
7. Influence of African religion in cultural expressions

8.7 Conclusions of the study

The study has managed to investigate the origin of AmaNdebele mathematical artefacts in KwaMsiza, Mabhoko community, North-West province. Using an indigenous lens to conduct the study, the researcher has managed to present the historical and cosmic origin of AmaNdebele mathematica artefacts. Historically, this study has managed to discuss the history of the AmaNdebele artefacts, taking into consideration the history and development of the artefacts and styles. The study has presented results which show that the AmaNdebele artefacts existed before the Mabhoko war and even before they migrated to the Transvaal.

Therefore, the mathematical ideas and concepts in the artefacts were never influenced by the intruders/Boers but rather enhanced significantly after the war. On the other hand, the study has also captured information that states that it was the instructions of Supreme Beings for mathematical artefacts to be used as a cultural expression. According to the AmaNdebele worldview, the ancestors are the main reason for the origin of the mathematical artefacts. The meaning of geometric shapes was also discussed in this study and most of the meanings are linked to the Ndebele spirituality

and religion. This is to prove that religion and spirituality are the basis of the AmaNdebele mathematical artefacts.

The AmaNdebele continue to use the artefacts as an ethnic identity and to express their culture. They use mathematical artefacts in different ceremonies and annual commemorations. Beaded attires symbolize the gender, level, age and statuses of people while mural art on walls is done as an indication of an upcoming ceremony. The knowledge of mathematical artefacts has been shared from one generation to another and local strategies have also been developed by custodians to protect, preserve, and benefit from this knowledge. For many years, the KwaMsiza community has been selling and decorating their household with geometric patterns for both local and international tourists. They have also adapted to the new designs and sell fashionable artefacts to customers.

The KwaMsiza Mabhoko area was declared a heritage site by government based on its history and long-standing Ndebele traditional practices by the community. However, the infrastructure is collapsing based on lack of maintenance by the government. The community has shown major concern also about being ignored by the government and about the fact that their knowledge ois not part of the curriculum. They have called for the inclusion of Ndebele indigenous knowledge to be part of the classroom content so that their children can learn about their culture in formal schools. Such is also seen as a strategy to protect the indigenous knowledge of the AmaNdebele.

The study has also focused on legal documents that protect the indigenous knowledge Systems in South Africa. It was argued that legal documents exist however, there has been a struggle for knowledge holders to understand their rights because of the poor educational approaches/ programs not in place. Thus, the Department of Science and Technology advocated for the NIKSO, NIKMAS and NRS in order for local communities to learn about their rights and how they can financially benefit from their knowledge. This approach is significant because many knowledge holders have been exploited and misrepresented for years. This study was necessary to capture the worldviews of AmaNdebele regarding the origin of the mathematical artefacts, how the mathematical artefacts are used as culture identity and ways of which they are protected, and the custodians benefit from them. More academics from indigenous backgrounds may be inspired to do studies like this one from their own cultural groups,

utilizing an indigenous research lens, in order to contribute to the “movement” of decolonizing African research and education in general.

8.8 Recommendations

Based on the findings of this study, the following is recommended:

1. The AmaNdebele mathematical artefacts should be integrated in the curriculum. This will be a contribution from the Department of Education to the decolonization and indigenization of education which many indigenous scholars are calling for.
2. There needs to be more campaigns and traditional workshops in indigenous communities where knowledge holders are taught about their intellectual property rights.
3. The campaigns in communities should also teach people about the benefit sharing agreement and how to legally deal with exploiters.
4. Before policies and frameworks are drafted, community representatives need to be present in meetings with policy makers to discuss concerns of communities and their suggestions on what should be included in polices related to indigenous knowledge.
5. Researchers need to familiarize themselves with African philosophies so as to conduct research that adheres to customary laws and represents knowledge holders.

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LIST OF APPENDICES

Appendix 1: Focus group interviews (for AmaNdebele artefacts custodians with historical knowledge)

For objective one: which is to investigate the historical origin of the AmaNdebele mathematical artefacts.

Section A: Demographics

1. Marital status of the participant

Single ☐ Married ☐

Widowed ☐ Divorced ☐

2. Gender of the participants

Male ☐ Female ☐

3. Age of the participant

18-28 years ☐ 51-61 years ☐

29-39 years ☐ 62 and above ☐

40-50 years ☐

4. Experience as a knowledge holder

0-10 years ☐ 31-40 years ☐

11-20 years ☐ 41 and above ☐

21-30 years ☐

Section B: Discussions

Researchers welcome and introduction to participants: Welcome and I would like to thank you for volunteering to participate. This focus group discussion is designed to assess your knowledge about Ndebele crafts. The focus group discussion will take no more than two hours of your time. Despise being recorded, I would like to assure you that this discussion will be kept anonymous, and this researcher will follow all protocol stated by the consent form. May I please record the discussion to facilitate its recollection?

Rules for the participants

a. I would appreciate if one person speaks at a time.

b. There are no right or wrong answers in this discussion.

c. You are not bound to speak in a particular order.

d. When you do have something to say, please do so but only if someone has finished talking and you do not have to agree with the views of other people in the group.

Self-introduction by participants

• Firstly, before we begin, I would like everyone to briefly introduce themselves.

Questions

1. What is the origin of mathematical artefacts of AmaNdebele ?
2. How did the Ndebele mathematical artefacts come about?
3. What is the history of Ndebele mathematical artefacts?
4. What is the cosmic genesis of the AmaNdebele mathematical artefacts?
5. What is the impact of spirituality on Ndebele mathematical artefacts?
6. What role does spirituality play in the Ndebele culture
7. Why and how does Ndebele mathematical art serve as a culture identity
8. According to what you know, what does the Ndebele mathematical artefacts represent?
9. What is the meaning of the geometric shapes in Ndebebe mathematical artefacts?
10. How has this knowledge being preserved and protected?
11. Why are women specifically chosen to be custodians of Ndebele artefacts?
12. Is there anything, which you would like to add?

Appendix 2 : Semi-structured In-depth interviews (for custodians of AmaNdebele mathematicsl artefacts)

For objective two: To investigate the cosmic genesis of the AmaNdebele mathematical artefacts.

Section A: Demographics

1. Marital status of the participant

Single ☐ Married ☐

Widowed ☐ Divorced ☐

2. Gender of the participants

Male ☐ Female ☐

3. Age of the participant

18-28 years ☐ 51-61 years ☐

29-39 years ☐ 62 and above ☐

40-50 years ☐

4. Experience as a knowledge holder

0-10 years ☐ 31-40 years ☐

11-20 years ☐ 41 and above ☐

21-30 years ☐

Basic questions

1. What is the cosmic genesis of the AmaNdebele mathematical artefacts?
2. What is the impact of spirituality on Ndebele mathematical artefacts?
3. According to what you know, what does the Ndebele mathematical artefacts represent?
4. What is the symbolic meaning of the geometric shapes in the Ndebele artefacts?
5. How did the naming of the shapes come about?

6. What are the Ndebele mathematical shapes are associated with?
7. What is the role of Ndebele spirituality in the symbolic naming of Ndebele geometric shapes?
8. What are the beliefs and worldviews of the Ndebele people about the geometric shapes in the artefacts?
9. Why are women responsible in making the Ndebele geometric artefacts?
10. Where do Ndebele people trace their genesis?
11. Is there anything, which you would like to add?

Appendix 3: Focus group interviews (for Ndebele men and women who take part in ceremonies and commemorations)

For objective three: to explore how the AmaNdebele mathematical artefacts serve as culture identity.

Section A: Demographics

1. Marital status of the participant

Single ☐ Married ☐

Widowed ☐ Divorced ☐

2. Gender of the participants

Male ☐ Female ☐

3. Age of the participant

18-28 years ☐ 51-61 years ☐

29-39 years ☐ 62 and above ☐

40-50 years ☐

4. Experience in practicing Ndebele crafts

0-10 years ☐ 31-40 years ☐

11-20 years ☐ 41 and above ☐

21-30 years ☐

5. Years of practicing Ndebele customs and traditions

0-10 years ☐ 31-40 years ☐

11-20 years ☐ 41 and above ☐

21-30 years ☐

Section B: Discussions

Researchers welcome and introduction to participants: Welcome and I would like to thank you for volunteering to participate. This focus group discussion is designed to assess your knowledge about Ndebele crafts. The focus group discussion will take no more than two hours of your time. Despise being recorded, I would like to assure you that this discussion will be kept anonymous, and this researcher will follow all protocol stated by the consent form. May I please record the discussion to facilitate its recollection?

Rules for the participants

- I would appreciate if one person speaks at a time.
- There are no right or wrong answers in this discussion.
- You are not bound to speak in a particular order.
- When you do have something to say, please do so but only if someone has finished talking and you do not have to agree with the views of other people in the group.

Self-introduction by participants

• Firstly, before we begin, I would like everyone to briefly introduce themselves.

Questions

1. How does Ndebele mathematical artefacts serve as culture identity?
2. When do you express mathematical artefacts in the Ndebele culture
3. Why do Ndebele mathematical artefacts serve as culture identity?
4. What is the connection between rituals and Ndebele mathematical artefacts?
5. What has influenced the Ndebele mathematical art to serve as a culture identity?
6. Who are responsible to express the Ndebele identity?
7. What is the role of women in culture expression and preservation of the Ndebele identity?
8. How long has Ndebele mathematical artefacts served as culture identity?
9. Is there anything, which you would like to add?

Section c: Observation overview of attires worn by women and men during ceremonies to express culture identity.

Type of attire during ceremonies	Level and status	Age	Term in IsiNdebele language
		3-	

Appendix 4: in-depth interviews (for Ndebele knowledge holders who know ways of preserving knowledge)

For objective four, which is to explore how, the AmaNdebele mathematical artefacts have been protected and preserved

Questions

1. How has the Ndebele mathematical artefacts been protected and preserve
2. Who are responsible for protecting and preserving the artefacts?
3. Why are certain people responsible for protecting and preserving the Ndebele mathematical art?
4. What has inspired you to practise these artefacts?
5. What has inspired you to preserve and protect these artefacts?
6. What are the challenges that have been faced when protecting and preserving this knowledge?
7. How do you benefit from the mathematical artefacts?
8. How many years have you been protecting and preserving the artefacts?
9. Is there anything else that you would like to add?

Appendix 5: Introductory letter from the IKS center

Faculty of Agriculture, Science and Technology

Indigenous Knowledge Systems

Private Bag X2046 Mmabatho 2745

Tel: (018) 389 2453

Fax: (108) 389 5775

Website: www.nwu.ac.za

01 December 2020

TO WHOM IT MAY CONCERN

This is to confirm that Ms Monicca Thulisile Bhuda, is a registered student at the North-West University, Mafikeng campus (student no: 24464937). She is working towards a PhD in Social Science with Indigenous Knowledge Systems in the Faculty of Agriculture, Science and Technology. Ms Bhuda is conducting a research entitled: The Origin of AmaNdebele mathematical artefacts in KwaMsiza Mabhoko community, North-West Province. The research requires her to conduct interviews with participants in order to collect data for research. The IKS centre has given Ms Bhuda permission to conduct the study at Mabhoko community in the Madibeng local municipality, North-West Province. The IKS centre will greatly appreciate if you allow her to continue with the research process in Mabhoko community

Yours sincerely

Dr M. Koitsiwe

Thesis promoter

Appendix 6: NWU ethics approval

NWU®
NORTH-WEST UNIVERSITY
NOORDWES-UNIVERSITEIT
YUNIBESITI YA BOKONE-BOPHIRIMA

Private Bag X1290, Potchefstroom
South Africa 2520
Tel: 018 299-1111/2222
Fax: 018 299-4910
Web: http://www.nwu.ac.za
Senate Committee for Research Ethics
Tel: 018 299-4849
Email: nkosinathi.machine@nwu.ac.za

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Faculty of Natural and Agricultural Sciences Ethics Committee (FNAS-REC)**, the Faculty of Natural and Agricultural Sciences Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SCRE) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: The Origin of AmaNdebele mathematical artefacts in KwaMsiza Mabhoko community, North-West Province
Study Leader/Supervisor: Dr MT Koitsiwe
Student: MT Bhuda

Ethics number:	N	W	U	-	0	1	7	7	6	-	2	0	-	A	9
	Institution				Study Number						Year			Status	

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application type: Single **Risk Category:** **Minimal**

Commencement date: 01/11/2020
Expiry date: 01/02/2022

Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special in process conditions of the research for approval (if applicable):

- The following documentation are archived by FNASREC and should be complete and kept up to date:
  - Research proposal
  - Signed approval from the scientific committee indicating the proposed risk category
- All researchers involved in the study should submit signed NWU code of conduct statements annually.
- All researchers of low risk studies should submit proof of relevant ethics training every two years.
- All researchers that take part in activities that pose a safety and security threat to the researchers or the environment should submit a risk assessment form annually.
- All research involving human interaction should follow best ethical practise and keep documents as proof. This includes informed consent, questionnaires, incorporation of risk-benefit, and responsible data management.
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the FNASREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

File reference: 9.1.5.4.2 Page 1 of 2

Appendix 7: Participant consent form in indigenous knowledge research

Title of Study: The Origin of AmaNdebele mathematical artefacts in KwaMsiza Mabhoko community, North-West Province

Description of the research and your participation

You are invited to participate in a research study conducted by Bhuda Monicca Thulisile who is doing a PhD in Social Sciences with Indigenous Knowledge Systems. The study explores the origin of AmaNdebele mathematical artefacts in KwaMsiza, Mabhoko community, North-West province. There are no known risks associated with this research. There are no financial known benefits to you that would result from your participation in this research. Rather, this study will add to the current existing literature about the Ndebele culture and their history and a copy of a published journal article will be issued to the local municipality in order to be distributed in local libraries.

As a researcher, I will do everything possible to protect your privacy such as not disclosing your identity in any publication resulting from this study. Your participation in this research study is voluntary. You may choose not to participate, and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study.

Contact information

If you have any questions or concerns about this study or if any problems arise, please contact the supervisors on +27183892453 during working hours and request for Dr M Koitsiwe (promoter) or Dr Z Zulu (co-promoter).

Consent

I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant's signature_____ Date: _____

Appendix 8: Participant non-disclosure agreement

The origin of AmaNdebele mathematical artefacts in KwaMsiza Mabhoko community, North-West Province

This Nondisclosure Agreement (the "Agreement") is entered into by and between _____ with intended participants' _____ ("Disclosing Party") and _____, located at _____ ("Receiving Party") for the purpose of conducting research on the Origin of AmaNdebele mathematical artefacts in KwaMsiza Mabhoko community, North-West Province.

Exclusions from Confidential Information: Receiving Party's obligations under this Agreement do not extend to information that is: (a) publicly known at the time of disclosure or subsequently becomes publicly known through no fault of the Receiving Party; (b) discovered or created by the Receiving Party before disclosure by Disclosing Party; (c) learned by the Receiving Party through legitimate means other than from the Disclosing Party or Disclosing Party's representatives; or (d) is disclosed by Receiving Party with Disclosing Party's prior written approval.

Obligations of Receiving Party: Receiving Party shall hold and maintain the Confidential Information in strictest confidence for the sole and exclusive benefit of the Disclosing Party. Receiving Party shall not, without prior written approval of Disclosing Party, use for Receiving Party's own benefit, publish, copy, or otherwise disclose to others, or permit the use by others for their benefit or to the detriment of Disclosing Party, any Confidential Information. Receiving Party shall return to Disclosing Party any and all records, notes, and other written, printed, or tangible materials in its possession pertaining to Confidential Information immediately if Disclosing Party requests it in writing.

Integration. This Agreement expresses the complete understanding of the parties with respect to the subject matter and supersedes all prior proposals, agreements, representations, and understandings. This Agreement may not be amended except in a writing signed by both parties.

Appendix 9: Benefit sharing agreement

Title of Study: The Origin of AmaNdebele mathematical artefacts in KwaMsiza Mabhoko community, North-West Province.

Benefit sharing agreement (of indigenous knowledge)

between _____ and

_____

1. **User of indigenous knowledge associated with Ndebele mathematical art**

The permit applicant is_____as registered company/ or natural person in terms of South African Laws

The relevant details of the company/ organisation/ institution are**:**

_____

_____

Contact details **contact person**

2. **Indigenous knowledge holder associated with Ndebele mathematical art**

The indigenous knowledge holder is _____ as a (natural person or Indigenous Community) in terms of South African Laws

The relevant details are:

_____ _____

_____

Name **contact details** **contact person**

_____

State name of principal (If entering into agreement in a representative capacity)

3. **Sharing of benefits**

3.1 Monitory benefits: The researcher will not compensate participants'/knowledge holder with money because this study is for academic purposes and not for any financial benefits.

3.2 Non monitory benefits: The local municipality together with the participants of this study will have access to research data for any clarity or verification. After the study has been published, the municipality on

behalf of the community will have access to the article and receive their own copy that can be sourced in local libraries.

4. **Review of agreement**

4.1 This agreement will be reviewed every _____ (fill in agreed timeframe), with a view to amending the agreement if necessary.

5. **Third party**

5.1 The applicant undertakes not to transfer the indigenous knowledge associated with Ndebele ethnomathematics to a Third Party, without the written authorization of the indigenous knowledge holder; and then only under a legally binding written agreement with the indigenous knowledge holder based on this Agreement.

6. **Other matters**

6.1 Any other matters or conditions which the parties to this agreement wish to record**:**

7. **Breach of termination**

7.1 If a party to this agreement (“the breaching party’’) breaches any material provision of this agreement, the other party (“the aggrieved Party’’) shall be entitled to deliver to the breaching party a written notice requiring the breaching party to rectify that breach within 30 days of receipt. If the breaching party remains in breach of such provision within 30 days after receipt of the notice, the aggrieved party shall be entitled (without derogating from any of its other rights or remedies under this agreement or at law).

7.2 To sue for immediate specific performance of any of the defaulting party’s obligations under this agreement, whether such obligation is then due or not.

7.3 To cancel this agreement, in which case written notice of the cancellation shall be given to the defaulting Party, provided that the remedy of specific performance or damages would not adequately prevent the aggrieved party from being prejudiced.

_____ _____

Name of traditional holder/ Community representative **Signature** **Date**

_____ _____

Name of applicant **Signature** **Date**

_____ _____

Name of municipal authority **Signature** **Date**

Appendix 10: Material transfer agreement

Notes

1. This agreement must be entered into by an applicant for a permit and any stakeholders identified in terms of the regulations who provide or give access to indigenous knowledge resources.

2. If there is more than one stakeholder a separate agreement must be entered into with each stakeholder.

3. If insufficient space is provided in this form, additional information may be included by way of annexures. Alternatively, parties can elect to use their own forms with sufficient space provided for each Regulation, as long as those forms follow the general format of this form.

4. The parties to this agreement must sign the agreement in the space indicated and must initial every other page of the agreement, including any annexures.

1. Recipient of indigenous art, if recipient is a juristic person:

1.1. Name of institution or body: _____

_____

1.2. Registration no. of institution or body: _____

1.3. Contact details of institution or body (including postal/physical address, phone, fax, and e-mail address): _____

_____

1.4. Name of contact person in institution or body (attach a certified copy of ID document): _____

_____

1.5. Capacity of contact person: _____

2. Recipient of indigenous art, if recipient is a natural person

2.1. Name of recipient: _____

2.2. Identity number of recipients: _____

2.3. Contact details of recipient (including postal/physical address, phone, fax and e-mail address): _____

_____

3. Provider of access to indigenous art

3.1. Name: _____

3.2. Capacity: _____

3.3. If entering into agreement in a representative capacity, state name of principal: _____

3.4. Contact details (includes physical/postal address, telephone, Fax and e-mail address): _____

_____

4. Indigenous art

The type, quantity, and source of indigenous biological resources to which this agreement relates are –

Beaded artefacts	**Painted artefacts**

5. Current uses of the indigenous art

The present potential uses of the indigenous resources/ art to be used/collected are the following -

_____

_____

6. Purpose of export (if applicable)

The indigenous arts are to be exported for the following

Purposes –

_____

_____

7. Third parties

The recipient may only provide any such indigenous art or their progeny to third parties in terms of the following conditions (fill in detail below) -

_____

_____

The recipient agrees to take every reasonable precaution to prevent the identified indigenous art coming into the possession of any unauthorized third party.

8. Entire Agreement

This agreement constitutes the entire agreement between the parties in regard to the subject matter of this agreement and no addition to, variation or cancellation of this agreement or waiver of any rights under this agreement will be of any force or effect unless reduced to writing and signed by the parties to this agreement.

Signature of an applicant for permit: _____Date: _____

Capacity of signatory: _____

On behalf of: _____

Signature of access provider of resource: _____Date: _____

Capacity of signatory: _____

On behalf of: _____

Approved by the Minister of Water and Environmental Affairs

_____

Signature

_____

Date

DEPARTMENTAL CONTACT DETAILS

All completed documents must be mailed to:

THE IKS CENTER

Postal address:

North-West University

Mafikeng Campus

Private Bag X2046

Mmabatho

2745

FOR THE ATTENTION OF THE DIRECTOR: RESOURCE USE

Enquiries:

Miss. Kgothatso Mafiri (secretary) Tel: 018 389 2453

Fax: 0183892837 E-mail: 23187697@nwu.ac.za

Appendix 11: Approval letter from the Ndzundza Mabusa Kingdom

Dear Sir / Madam

Permission letter to conduct a study in KwaMsiza, Mabhoko community

The Ndzundza Mabusa traditional council and authority of AmaNdebele gives Ms MT Bhuda (PhD candidate.), student number 24464937 permission to conduct a study at KwaMsiza, Mabhoko community, situated in Klipgat, Madibeng local municipality. The study entitled *The Origin of AmaNdebele mathematical artefacts in KwaMsiza Mabhoko community, North-West Province* can be conducted from December 2020 to May 2021. The traditional council is satisfied with the information provided regarding this study hence permission is granted to the researcher to work with the community.

For any inquiries, please contact the King and representative of Ndzundza Mabusa Kingdom on tell: 071 461 0475 Email: mahlangu.etwell@gmail.com

Yours sincerely

Ikosi Sipho Etwell Mahlangu

29 January 2021

Umbuso Sitjhaba weNdzundza Mabusa